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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled:

Design of an Orientation System for the University of Alberta, Accessible for Users with Low Vision: An Inclusive Design Process

Submitted by Ximena Leonor Rossello in partial fulfillment of the requirements for the degree of Master of Design.

Design of an orientation system for the University of Alberta, accessible for users with low vision: an inclusive design process

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Master's Thesis Project
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ABSTRACT

The wayfinding system currently used at the University of Alberta main campus is not accessible for users who are blind/partially sighted, making the navigation process difficult for them. The lack of directional clues and points of reference, accessible for people with low vision, may result in disorientation, loss of track and possibly, accidents. This Visual Communication Design Master's thesis project presents the proposal for an outdoor orientation system, for the University of Alberta, accessible for students who are blind/partially sighted. In order to create this accessible orientation system, a user-centered design process was followed, with an inclusive and collaborative approach. In order to determine specific needs for orientation and navigation, the research design involved consultations with orientation and mobility experts, and a series of interviews with blind/partially sighted students. A benchmarking task was conducted, to observe the on-campus navigation of students who have low vision. A prototype for the proposed orientation system was produced and tested with blind/partially sighted students at the University of Alberta. The data collected during the testing procedure was analyzed, using both a quantitative and a qualitative approach, to determine the level of accessibility of the system and to reveal if the overall navigation experience was positive or negative for participants in the study. Users' preferences, recommendations for improvement of the system, and opportunities for further research were outlined.

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CONTENTS

I. INTRODUCTION

In 2002 the World Health Organization (WHO) estimated that, worldwide, 161 million people had low vision, and that from this group 37 million people were legally blind (Resnikoff et al., 2004). According to Statistics Canada, more than 600,000 Canadians live with a vision problem that cannot be corrected using ordinary lenses. Current projections indicate that this number will increase dramatically over the next 10 years, because the population is aging (Canadian National Institute for the Blind [CNIB], 2006d).

The visual limitations of people who are blind/partially sighted will have an impact on several aspects of life, especially if the onset of blindness is late. It may have an adverse effect on the social interactions of blind/partially sighted people, their possibilities of recreation, and their ability to orient themselves and navigate (Ryan, 2002). With the objective of examining the needs of people who live with low vision, the Canadian National Institute for the Blind (CNIB) National Research Unit conducted a study, entitled *An unequal playing field: report on the needs of people who are blind or visually impaired living in Canada.* Results of this study revealed that, in the daily lives of blind/partially sighted people, the reduced capacity to do things they want to do, and their feelings of isolation, were the most relevant consequences of having unmet needs (Gold, Simson & Zuvela, 2005). It is important to note that, if the needs of people who are blind/partially sighted were acknowledged and properly addressed, they would cope with the problems that result from having low vision, living an independent and productive life (CNIB, 2006b). Information from the CNIB website indicated that "Blindness does not prevent people from accomplishing their goals; it only affects how these goals are accomplished" (CNIB, 2006b, www.cnib.ca/community/nfllrd/services/general/list.htm).

Researchers advocating for accessibility have suggested that the label of *disability* should move from the user to the environment. In the book *Inclusive design: design for the whole population*, the authors stated that "Disability arises not within the individual, due to impaired capability, but as a result of environments, products and services that fail to take into account the needs and capabilities of all potential users" (Clarkson, Coleman, Keates & Lebbon, 2003, p. 1). From the perspective of visual communication de-

sign, the considerations presented above imply that blind/partially sighted people should be included in users groups, and reveals the importance of including the user into the design process. It is not a matter of asking if blind/partially sighted people should be included as potential users for any designed product or object; the question is *how* could their needs be addressed, in order to be included.

This Visual Communication Design Master's thesis project explored the issues involved in a design process that took into account the needs of people who have low vision, in order to be inclusive and accessible for them. This research presents the development and proposal of an outdoor orientation system, for the University of Alberta, accessible for blind/partially sighted students.

2. PROBLEM DEFINITION

The wayfinding system currently used at the University of Alberta is not accessible for users who are blind/partially sighted. The U of A main campus covers about 50 city blocks with more than 90 buildings (University of Alberta, 2005). Considering the large number of buildings and open areas, and that the present sign system relies exclusively on visual means of communication, outdoor navigation at the University of Alberta is difficult for students who are blind/partially sighted. The lack of directional clues and points of reference perceptible for people with low vision, may result in disorientation, loss of track, and possibly, accidents.

In a personal communication, Janice Brandt, Orientation and Mobility Trainer for the Canadian Institute for the Blind (CNIB), explained that for students who are blind/partially sighted, on-campus navigation depends on the availability of accessible landmarks and cues; that is, objects that can be perceived by auditory, tactile and/or olfactory means, or by using residual sight (January 23, 2006). When consulted about frequent problems encountered by blind/partially sighted students, Jean Jackson, Advisor and Alternate Format Coordinator for the Specialized Support and Disability Services (SSDS) at the University of Alberta, explained that students with low vision might need to navigate alternate routes, which often take longer, if the most direct route connecting two facilities does not have any landmarks. For example, to go from School of Business Building to Cameron Library (a five minute walk taking the most direct route), some students who have low vision need to:

1. Go from School of Business Building to HUB Mall.

2. Walk south through HUB Mall.

3. Take the Light Rail Transit (LRT) University Station pedway.

4. Walk west and exit the LRT by the Dentistry/Pharmacy Centre.

5. Take a path through Civil/Electrical Engineering Building towards Central Academic Building (CAB).

6. Follow the pedway connecting CAB to Cameron Library.

This alternate route (see Figure 1) takes approximately 45 minutes, yet blind/partially sighted students will use it, because the most direct route has no landmarks (J. Jackson, personal communication, August 26, 2005).

During an informal meeting with blind/partially sighted students organized by the SSDS, conducted in September 2005, students expressed their concern about on-campus accessibility at the University of Alberta. Students claimed that some outdoor areas were difficult to navigate due to the lack of landmarks and the complex layout of the pathways, and that most of the time they required assistance to find their way and to reach their destination promptly, a situation that affected their independence.

The objective of this Master's thesis project was to develop a proposal for an orientation system, accessible for University of Alberta students who are blind/partially sighted.

Figure 1. Most direct route and alternate route from School of Business to Cameron Library.

- ▬ ▬ Most direct route
- ▬▬ Alternate route
- •••• Underground path
- 🏛 Library
- 🍴 Food services

3. RESEARCH QUESTION

A wayfinding system for the University of Alberta, based on more than visual means of communication, could make the information accessible for users who have low vision. An accessible orientation system, that provides relevant information, could help blind/partially sighted people to orient themselves better while navigating on campus. In addition, it may improve blind/partially sighted students' traveling time, by making navigation time more efficient. It was hypothesized for the purposes of this Master's thesis project that, by following a user-centered design process, it would be possible to create an outdoor orientation system for the University of Alberta campus, accessible for students who are blind/partially sighted.

The following research question was formulated:
How can outdoor on-campus orientation and navigation be improved for University of Alberta students who are blind/partially sighted?

The research question was broken down into four specific questions, which addressed the possible limitations and sensorial requirements of the users, the potential contribution of an accessible orientation system, and the process to be followed in order to accomplish the project objectives:

1. *Is it possible to create an effective and inclusive system, accessible for all people, regardless of the level of sight?*

2. *Which sensorial systems should be addressed by the orientation system, in order to be accessible for blind/partially sighted users?*

3. *In which ways would an accessible orientation system affect the navigation process for students with low vision?*

4. *What methodology should be followed, to ensure that the needs of users with low vision are taken into account?*

3.1 User-centered design

The concept of user-centered design advocates for the creation of products or communications accommodating the specific requirements of people (Frascara, 1997; Norman, 1988). In the book *The design of everyday things*, Donald Norman stated that the design of every object should be based on

1. Jorge Frascara, Professor
   Emeritus of Visual Commu-
   nication Design, Department
   of Art and Design at the
   University of Alberta, has
   conducted extensive research
   of graphic design for safety
   and other social concerns,
   including the importance of
   considering the users' needs
   through the design process.

the needs of the user, setting the emphasis on the usability, to ensure things are easy to use and understand.

In his book *User-centred graphic design*, Jorge Frascara[1] (1997) outlined four distinct areas of responsibility related to the design practice:

1. *Professional responsibility*, which concerns the ability to create messages that are detectable, distinguishable, attractive, understandable and convincing.

2. *Ethical responsibility*, which regards the creation of communicational messages that recognize the humanity of the addressees.

3. *Social responsibility*, which concerns the creation of messages that make a positive contribution to society.

4. *Cultural responsibility*, which relates to the creation of an object that enriches the cultural existence of the public, beyond the functional purposes of design.

According to Frascara (1997, 2004), the role of designers is to communicate the intended message efficiently and accurately; therefore, understanding the needs of the end user is crucial. The author explained, "Communication is the reason for the existence of visual communication design, and represents the origin and the objective of all work in the field" (2004, p. 63). Frascara (1997) stated that the main problem the designer faces is related to the relationship between the user and the communicational piece, and not to the relationship among the visual elements involved in the designed piece. He explained that visual design is centered on human behaviour, rather than on visual forms (1997).

According to Frascara (1997), designers should develop design methods for research, that is, tasks of a higher order than the design of visual communications. These methods will result in data to work with that move towards an efficient and effective user-centered practice (Frascara). Frascara also stated that these methods should bridge the design theory (which usually remains self-referential) with practice (which is commonly based on intuition). In addition, design methods should be flexible enough to adapt to the requirements of each design problem.

2. The term *universal design* was first introduced in the early 90s by Ron Mace, architect, product designer and educator, graduated from the School of Design at North Carolina State University, who founded the Center for Universal Design (The Center for Universal Design, 2006).

3.2 *Universal design* and *inclusive design*

In the past years, with the introduction of concepts like user-centered design, the attention and importance given to the design of accessible products have increased, in order to allow equal opportunities for people to participate in society (Iwarsson & Stahl, 2003). Historically, the principle of *accessibility* was focused on accommodating people with disabilities (Lidwell, Holden & Butler, 2003). Presently, *accessibility* refers to the capacity of a designed object to be usable, without modification, by as many people as possible (Lidwell, Holden & Butler). Likewise, the concept of *universal design* or *inclusive design* goes a step beyond the idea of adapting and designing special devices for people with disabilities, striving for accessibility for everyone (Story, Mueller & Mace, 1998).

The concept of *Universal design*[2] was defined as "the design of products and environments to be usable by all people, to the greatest extent possible, without adaptation or specialized design" (Story, Mueller & Mace, 1998, p. 2). Universal design represents *accessibility for all*, considering that the user could be a child, an elder, a person with atypical height or weight, or people with physical or mental disabilities (Story et al.). In the book *The universal design file: Designing for people of all ages and abilities*, the authors stated that "designers are trained to design for a mythical 'average' group of people, but in fact this group does not exist. Every individual is unique and as a group, the human species is quite diverse" (Story et al., p. 2). Instead of classifying users in categories, such as *people with disabilities* and *people without disabilities*, universal design responds to the broad diversity of users, addressing the human need to interact with the environment and the objects present in it (Sandhu, 2000).

Universal design emerged first in architecture, but later expanded to the designed objects available in the environment including computers, telephones and all kind of information systems (Tobias, 2003). Story et al. (1998) explained that a multidisciplinary group—including architects, product designers, engineers and environmental design researchers—collaborated to assemble a set of seven principles, which should be used as a design guide. If the designed environment or object fulfills the seven principles, it will be considered as a universal design product (Story et al.). The authors also affirmed that the principles could work as a checklist,

to evaluate the accessibility of existing designs. According to Story et al., the seven principles of universal design are:

1. *Equitable use:* the design is useful and marketable to people with diverse abilities.

2. *Flexibility in use*: the design accommodates a wide range of individual preferences and abilities.

3. *Simple and intuitive use*: use of the design is easy to understand, regardless the experience, knowledge, language skills, or current concentration level of the user.

4. *Perceptible information*: the design communicates necessary information effectively to the user, regardless of ambient conditions or the sensory abilities of the user.

5. *Tolerance for error*: the design minimizes hazards and the adverse consequences of accidental or unintended actions.

6. *Low physical effort*: the design can be used efficiently and comfortably, with a minimum of fatigue.

7. *Size and space for approach and use*: appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

Inclusive design, like *universal design,* is a *design for all* approach, emerged in the UK and other European countries (Coleman, 1994, as cited by Clarkson et al., 2003) from collaborations between industry, designers, researchers and educators. The ultimate aspiration of inclusive design is to develop products and services that meet the needs of the whole population (Clarkson et al.). Inclusive design is seen as a goal-oriented process, an aspect of design practice, rather than a genre of design or a performance measure (Clarkson et al.).

Clarkson et al. (2003) explained that *universal design* is a response to the demand of consumers that all designs should be universally accessible and usable, focusing on the assertion of individual consumer rights, and placing the responsibility on the provider, supplier or designer when the products or services do not fulfill expectations. *Inclusive design*, on the other hand,

centers on social inclusion. Clarkson et al. stated, "The focus [of inclusive design] is not on age or disability, although these are very important issues, but on inclusivity at a social level" (p. 10). Designing inclusively means a process of design, aimed at including people who might normally be ignored (Evamy & Roberts, 2004).

Although both concepts, *universal design* and *inclusive design*, aim at accessibility for all, the ideas behind inclusive design related more directly to the underlying goals of this thesis project. The inclusive design concept appeared to be more flexible than universal design, and it seemed to signify more than simply meeting the objective of being accessible for all, in that an inclusive design project suggested the use of an inclusive research method as well. An orientation system designed to be accessible for blind/partially sighted students may not be considered a *universal design*, because the design process would be focused on a particular audience, rather than *all people*. However, this could be considered as an *inclusive design* project, because it regards the creation of an orientation system accessible for those users who were not taken into account for the current wayfinding system. If the proposed orientation system complies to be perceptible, legible and useful for people with all levels of vision, blind/partially sighted users would gain access to necessary information for navigation at the U of A campus.

3.3 Research design
One of the objectives of this research was to work with users who are blind/partially sighted, content experts, and the University of Alberta, following an inclusive and collaborative process. The methodology proposed for the design and evaluation of the orientation system followed a series of steps, which involved both a quantitative and qualitative approach:

Background research
a. *Literature review*
   The literature review was conducted to obtain valuable information in order to set a foundation for the development of the proposal. Areas studied included:
   • visual abilities and levels of visual perception

- spatial orientation and wayfinding
- navigation for people with low vision
- aids for people with low vision
- design of legible texts for people with low vision
- accessibility policy at the University of Alberta

b. *Consultations with content experts*

A dialogue with content experts, including specialists from the Canadian National Institute for the Blind (CNIB), the Royal National Institute for the Blind (RNIB), and the University of Alberta Specialized Support and Disability Services (SSDS), was established to collect relevant information about how to create an orientation system that is accessible for blind/partially sighted people.

Design investigation

a. *Student interviews*

To ensure a user-centered approach, that includes the user into the design process, a series of interviews was conducted with University of Alberta students who are blind/partially sighted. The objectives of these interviews were to discern specific needs regarding on-campus mobility, to help determine which features should be included in the physical devices comprising the system. In addition, student interviews helped to delineate a specific route on campus, which was complex enough to be a real test of the resulting system.

b. *Benchmarking of the environment*

A benchmarking task, conducted at the beginning of the design procedure, consisted of asking student participants to walk a specific route, without an available orientation system. The task was performed to determine how efficient the navigation process at the University of Alberta was for students who are blind/partially sighted. The findings from the analysis of this task helped to make an estimation of how much, in terms of time management, safety and confidence, blind/ partially sighted students were affected by a wayfinding system that is not accessible to them. In addition, the observations made during the benchmarking task provided insight into the different techniques used, by people with low vision, for navigation and wayfinding.

Design response

a. Design of the orientation system

The findings from the background research and the design investigation helped to determine a set of guidelines for the possible design solutions of the system. Based on these guidelines, a formal proposal for the orientation system was presented

b. Production of the prototypes

A prototype of the proposed orientation system was produced, in order to evaluate its performance and determine if it was accessible for blind/partially sighted students.

Design evaluation

a. Prototype testing

The testing of the system involved installing the prototypes on the same route used for the benchmarking task, and testing their performance with the same student participants. The objective was to estimate the possible effects of implementing the proposed system at the University of Alberta, in order to provide evidence that the system could improve on-campus navigation of blind/partially sighted students; evaluate the effect of the system for on-campus navigation; and assess which features of the system were perceptible, legible and useful to participants. After the testing, participants were asked to answer a questionnaire and provide their feedback.

b. Discussion of testing results

The data collected was analyzed and discussed, using both a quantitative and qualitative approach, to elucidate users' preferences, unexpected outcomes and design recommendations aimed at the improvement and further development of the system. Implications for further research that emerged from the evaluation process were distilled and summarized.

4. BACKGROUND RESEARCH

The review of the literature and the dialogue with the experts contributed to set a background for the development of the orientation system. The information obtained from this research addressed the impact of having low vision for the process of wayfinding and navigation, outlined available aids for orientation and mobility of blind/partially sighted people, presented a set of recommendations for the design of legible information systems, and explained the accessibility policy at the University of Alberta.

4.1 Visual abilities: normal sight, partial sight and blindness

Normal vision is commonly known as 20/20. According to the Canadian National Institute for the Blind (CNIB), the first number of the fraction indicates the maximum distance, for a person being tested, to be able to perceive the object for the test—commonly, a vision chart (CNIB, 2006d). The second number indicates the maximum distance where a person with normal sight would detect the same object. For example, a visual acuity of 20/60 means that the eye being tested is able to see at 20 feet what a person with good vision can see at 60 feet (CNIB).

According to the World Health Organization (WHO), any person who is either legally blind or partially sighted would be considered to be someone who has a visual impairment or disability (Resnikoff et al. 2002). For this thesis project, the terms *low vision* and *blind/partially sighted* were used instead of *people with visual impairment* or *people with visual disability*, because it describes the audience yet it does not focus on the impairment.

Partially sighted people are not blind, yet they have limited vision. The World Health Organization defined partial sight as "visual acuity of less than 6/18, but equal to or better than 3/60, or a corresponding visual field loss to less than 20 degrees in the better eye with best possible correction" (Resnikoff et al. 2002, p. 845). The WHO also offers a definition that illustrates the limitations of being partially sighted, describing this impairment as "the inability to count fingers at a distance of 20 feet or less" (CNIB, 2006d). Likewise, the American Foundation for the Blind (2006) defines low vision as a functional limitation on seeing, which can be severe—the inability to see words and letters—or non-severe—difficulty seeing words and letters.

3. Kevin Lynch (1918-1984) is considered one of the leading environmental design theorists of the 20th century. His early studies were focused on how people perceive and organize their environments, and in the interaction between physical space and its human use (Banerjee, Lynch & Southworth, 1990).

According to the CNIB, a person is considered legally blind when the central acuity does not exceed 20/200 in the better eye with correcting lenses, or when the visual acuity—if better than 20/200—has a limit to the central field of vision of no greater than 20 degrees (CNIB, 2006d). From this definition it is understood that, although it is commonly assumed that blind people have absolutely no vision, this is not always true. Few blind people see nothing at all; some will have *light perception*, which is the ability to distinguish light, but nothing else (CNIB, 2006c).

Different limitations would be present, depending on the eye condition of a blind person (See Figure 2). According to the CNIB (1998), the following are the most common eye conditions and their impact on sight:

*   *loss of peripheral vision:* commonly known as *tunnel vision*
*   *loss of central vision:* condition often caused by macular degeneration, leading cause of visual disability in the elderly, that limits the ability to see fine detail; includes distorted, cloudy central vision
*   *blurred vision:* inability to see objects in focus—among other causes, extreme shortsightedness and uncontrollable eye movements can result in this condition
*   *night blindness:* difficulty to see under dark conditions
*   *colour blindness:* partial or total inability to perceive colour
*   *sensitivity to glare:* inability to see at bright light without pain

4.2 Wayfinding: perception and cognitive process

Wayfinding is the process of navigating and reaching a destination in a familiar or unfamiliar environment (Arthur & Passini, 1992). In 1960 Kevin Lynch[3] first introduced the concept, defining 'way-finding' as the process of understanding and structuring the environment for orientation purposes. In his book *The image of the city* (1960), Lynch observed that the ability of finding our way has more to do with the consistent use and organization of sensory cues from the surroundings, than some kind of supernatural instinct as was thought previously. Lynch also introduced the concept of *environmental image*, which he defined as a general mental representation of the external world necessary for orientation. Lynch explained that, for a city's layout, clarity and legibility are crucial factors that facilitate the creation of an environmental mental image.

Figure 2. Common eye conditions and their impact on sight, according to the CNIB
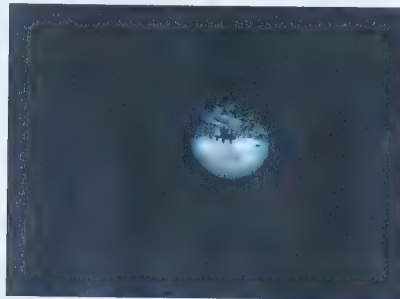
Tunnel vision

Blurred vision

Lost of central vision
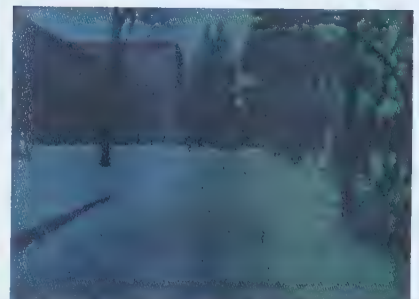
Night blindness

Lynch's theory, and the principles he outlined, created a model for contemporary wayfinding studies. Several authors (Arthur & Passini, 1992; Eriksson, Jansson & Strucel, 2003; Ohta, 1983) have developed Lynch's premise that wayfinding involves a series of cognitive processes, which demand different skills from the person. In order to gain a better understanding of how people find their way through their physical surroundings, it is essential to acknowledge and comprehend the following skills:

Cognitive mapping

According to Arthur and Passini (1992), a cognitive map is "an overall image or representation of the spaces and the layout of a setting" (p. 23). Like Lynch's *environmental image,* a cognitive map is a mental image, a pre-understanding of a determined environment, whether it is known or unknown for the person (Eriksson et al., 2003). Cognitive maps are used to find routes and determine the relative location of

places (Kuipers, 1983) in order to understand the way a setting is organized (Arthur & Passini).

The mental process that leads to the creation of cognitive maps is called *cognitive mapping* (Arthur & Passini, 1992). Arthur and Passini stated that external factors, such as the information the environment provides to the person, would affect cognitive mapping.

Spatial orientation

Spatial orientation is the sequence of processes that determine people's perception of the environment, and their existing representation of that environment and its surroundings (Ohta, 1983). According to Arthur and Passini (1992), spatial orientation is a skill that involves the ability to develop an accurate cognitive map of a setting, plus the capacity to place oneself within that mental representation. Perception of the environment is essential, because it determines the amount and quality of the information available for use in the orientation process (Ohta). In order to orient themselves, people need to acquire the information from the physical environment first, and then relate and integrate this data to the environmental representations already stored in memory (Ohta; see Figure 3). Arthur and Passini explained that, in general, a person would

Figure 3. Model of information processing for spatial orientation

Model adapted from
Ohta (1983, p. 106).

Perception → Orientation → Response selection

Environmental representation

Immediate physical environment

Response
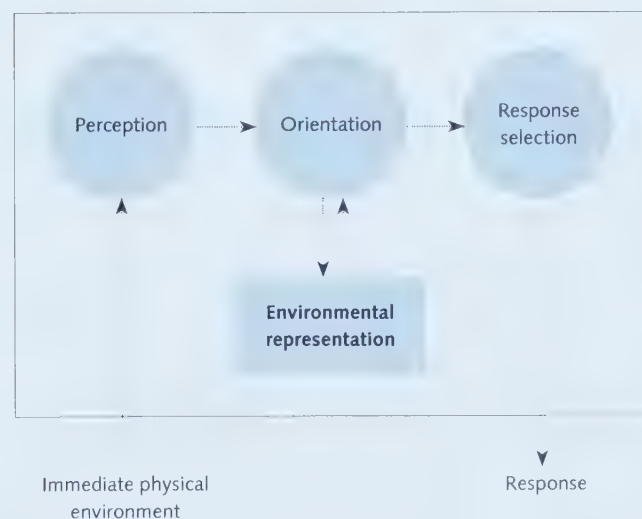
not need to physically move throughout a setting to achieve spatial orientation, because it is a mental skill.

Cognitive mapping and spatial orientation are important skills for wayfinding, because people need environmental knowledge that helps them to navigate and find their way through the surroundings, in order to reach their destination (Arthur& Passini, 1992; Baird & Wagner, 1983).

According to Arthur and Passini (1992), wayfinding demands action and behavior from the user who is navigating, to establish a dynamic relationship between the person and the settings. The authors explained that the process of wayfinding may involve several steps, depending on the complexity of the wayfinding task, such as:

- consideration of previous experiences
- reading and evaluating environmental context
- understanding spatial characteristics of the setting
- acquiring information displayed on signs, maps and indicators
- assessing alternate options
- contemplating other factors such as time, security,
  or interest of a given route

In their book *Wayfinding, people signs and architecture,* Arthur and Passini (1992) defined wayfinding as a spatial problem–solving task, comprised of three processes that are interrelated:

1. *Decision making: the development of a plan of action*
   Decisions involved in a plan of action are hierarchically structured, with the most general decisions on top and decisions regarding spatial behavior at the bottom (Arthur & Passini, 1992; see Figure 4). Complex wayfinding problems are then broken down into smaller problems to make them more manageable (Arthur & Passini).

2. *Decision execution: transforming the plan into appropriate behavior at the right place in space*
   A plan of action could act as a mental solution for a wayfinding problem, but would not take users to their destination physically. Decisions must be made and then transformed into behavior at the proper location.

3. *Information processing: the environmental perception and cognition*
   Regardless of how much planning is undertaken, the problem of
   reaching the final destination cannot be solved *before* performing the
   navigation task. Arthur and Passini (1992) explained that wayfinding
   is a *continuous* problem solving situation. Even if the user has a clear
   cognitive map and plan of action, it is only in the actual setting that the
   plan can be formulated completely, because information provided by the
   environment is also required. The process of acquiring the information
   from the environment is also known as *environmental perception*.

Figure 4. Diagram of hierarchically structured decision plan

Adapted from Arthur and
Passini (1992, p.30).

Decision 1
Go to destination
x in complex A

Decision 2
Go to complex
A

Decision 3
Go to garage

Decision 4
Park the car

Decision 5
Find address of
destination x

Decision 6
Go to garage
elevator

Decision 7
Consult directory

Decision 8
Go to 5th floor

Decision 9
Press call button

Decision 10
Enter elevator

Decision 11
Press floor button

Decision 12
Leave elevator on
5th floor

Decision 13
Go to
destination x

Decision 14
Check passage

Decision 15
Follow signs

Decision 16
Enter destination

The environmental perception necessary for navigation is based on scanning and glancing at the surroundings, in order to identify objects or messages of interest (Arthur & Passini, 1992). This process does not rely on vision alone. For sighted people, hearing is probably the second most used sense, allowing the identification of distant cues (Arthur & Passini). For people with visual impairments, sounds will provide information regarding distant objects, and tactile or haptic perception will apply to proximal objects. Perception of environmental cues, through the sense of smell, can also help to identify certain settings when navigating, although its use may be rather limited (Arthur & Passini; Gardiner & Perkins, 2005).

The role of visual communication design

Several studies (Arthur & Passini, 1992; Ohta, 1983) explained the importance of obtaining information from the environment for the wayfinding process. Environmental perception is important for the decision making and execution stages, and critical for the information processing stage (Arthur & Passini). However, it was observed that the necessary information is not always available to achieve environmental perception; and it is entirely possible for users to encounter ambiguous, even contradictory information when navigating (Arthur & Passini).

The way in which the environment is perceived, by users who are navigating, could be enhanced or diminished by several factors such as the planning of the setting, or the use of information systems for wayfinding (Arthur & Passini, 1992; Lynch, 1960). According to Jorge Frascara (1997, 2004), the design of information systems is an area of concern for visual communication designers. In his book *Communication design: principles, methods and practice*, Frascara (2004) identified four important areas within this discipline:

- design for persuasion
- design for education
- design for administration
- design for information, or information design—this particular area consists of information resources including information systems and signage for wayfinding

According to Arthur and Passini (1992) the challenge of information systems design is to enable safe, accessible and efficient spatial experiences, despite the complexity of the environmental setting. The authors explained, "the main design task for an existing setting is to develop an appropriate information system" (Arthur & Passini, p. 45). In his book *Visual function,* Paul Mijksenaar (1997) also described the impact of information design on the world, suggesting that visual communication designers are responsible for presenting information to users in an effective way. According to Mijksenaar, information should be as simple, clear an unambiguous as possible. Mijksenaar also stated that design, as a discipline, has the capacity to shape information by:

• emphasizing or understating
• grouping or sorting
• selecting or omitting
• comparing or ordering
• providing immediate or delayed recognition (layering information)

The role of visual communication designers is to use all the capacities and knowledge of their discipline to create effective orientation systems, providing the information users need to navigate in order to reach their destination. According to Frascara, "Visual detection and acuity, and comprehension, are central concerns in information design. The information designer should be conversant with perceptual and cognitive human factors" (2004, p. 130). This is applicable not only to environmental cues and signs commonly involved in a wayfinding system—which would be essential for the decision execution and information processing stages of navigation—but also to orientation resources that facilitate the decision making process, such as maps and information displays that users consult prior to navigation.

It is important to note that, from the inclusive design perspective, the role of designers should extend beyond the *visual* communication of the information to facilitate the wayfinding process, regardless of sensorial limitations users might have, and create orientation systems accessible for all. Arthur and Passini (1992) stated, "Environmental communication not only refers to the visual mode, but also includes the audible and the tactile

mode. All environmental communication, in order to be perceived and understood, must respond to basic laws of environmental perception and cognition" (p. 46). Visual communication designers may need an interdisciplinary approach, working in collaboration with experts from various fields, to achieve the goal of inclusive information systems.

4.3 Orientation and mobility: navigation for people with low vision

Traditional wayfinding theory often presents a different approach than the study of navigation for people with low vision, although both subjects seem to share a conceptual background. In order to comply with the concepts of inclusive design and to follow a user-oriented design process, it is essential to acknowledge the specific cognitive processes involved in navigation for people who are blind/partially sighted.

Hill and Ponder, authors of the American Foundation for the Blind's *Orientation and mobility techniques, a guide for practitioners,* defined *orientation* as "the process of using the senses to establish one's position and relationship to all other significant objects in one's environment" (1976, p. 3). *Mobility* is the term used to denote the ability of a person who is blind/partially sighted to travel independently (Foulke, 1983). The two concepts, orientation and mobility, are closely related and blind/partially sighted travelers need to be proficient in both areas to navigate efficiently (Hill & Ponder).

One of the most significant limitations for people with low vision is the difficulty of traveling independently (Golledge, 1993). According to Foulke (1983) and Golledge, pedestrians who are blind/partially sighted should be able to navigate on their own, undertaking mobility with efficiency, grace, comfort and safety. Hill and Ponder (1976) stated that the ultimate goal of orientation and mobility is to enable people with visual disabilities to enter any environment, familiar or unfamiliar, and to function independently by utilizing a combination of these two skills.

Skills required for independent orientation and mobility

Hill and Ponder (1976) presented a set of skills, which people with low vision must acquire for formal orientation and mobility training. The authors stressed the importance of developing these skills, explaining that they influence the user's level of proficiency in orientation and mobility,

determining the degree of independence for navigation. Hill and Ponder grouped these skills into three categories:

1. *Cognitive skills*
   Involve the ability to develop concepts like body imagery, nature of environment, spatial and temporal relationships and include the capacity for divergent thinking, problem-solving, decision making and the utilization of other senses. Cognitive skills include spatial orientation and cognitive mapping.

2. *Psychomotor skills*
   Include balance and coordination, posture and gait, the ability to walk in a straight line and execute turns, dexterity, stamina and reaction time.

3. *Affective skills*
   Include attitude, motivation, values and self-confidence.

Several factors may affect the acquisition of these skills, such as age, onset of blindness, past experiences, amount of functional vision, personality, and so on. Orientation and mobility trainers should be flexible and capable of adapting and modifying training skills, in order to meet the needs of the users (Hill & Ponder, 1976).

Cognitive processes related to orientation and mobility

Vision is frequently considered as the sense that plays the most important role for spatial orientation (Foulke, 1983). Several experts have recognized visual experience as a crucial element throughout the developmental process of cognitive imagery (Andrews, 1983). Different studies concerning orientation, mobility and navigation for blind/partially sighted people, reflected different opinions about the degree to which visual disabilities affect the cognitive processes necessary for wayfinding. Three theories have been developed to classify the conflicting results emerging from these studies (Fletcher, 1980):

1. *Deficiency theory*
   Experts adhering to this theory believe that the information from the environment, perceived by using sensorial modalities other than vision,

cannot provide an adequate base to formulate a spatial representation. According to this position, blind people are not capable of developing a cognitive map or establish spatial relationships for a given setting.

2. *Inefficiency theory*

Experts adhering to this theory believe that the lack of vision does not prevent people from creating a mental map, but that it would interfere in the process. Blind people would able to create a mental map to use as a reference for navigation, but it would not be as sophisticated as if they were sighted.

3. *Difference theory*

Experts adhering to this theory believe that a lack of vision slows down the development of spatial orientation skills, but does not prohibit it. Blind children's conceptual abilities for cognitive mapping show differences compared with the abilities of sighted children; however, the skills are generally equal when blind people reach adolescence.

Fletcher's theories provided a valuable overview and classification of the results of previous studies, although they did not answer the question of how people with low vision learn and understand spatial concepts. That seems to be a question still waiting to be answered.

Kitchin and Jacobson (1997) presented an assessment of the various techniques used by researchers to collect and analyze data concerning how people with low vision learn, understand, and think about space. The authors suggested that the techniques employed and the results of existing research were not conclusive and should be used cautiously, noting that most studies regarding spatial understanding and wayfinding abilities of blind/partially sighted people were conducted in microscale environments, and that studies testing wayfinding performance in real environments were only comprised of short routes (Kitchin & Jacobson).

Kitchin and Jacobson (1997) stressed the importance of conducting more research, because understanding how blind/partially people perceive and understand spatial concepts is crucial for developing accessible wayfinding systems and settings. The authors hypothesized:

An understanding of how persons with visual impairment or blindness understand space could lead to the planning of environments that are easy to remember and facilitate greater and more pleasurable use. This understanding could also provide knowledge about the content, form, and location of spatial information that should be made available to blind or visually impaired pedestrians. In addition, it could provide clues about how to enhance this group wayfinding and orientation skills by supplying feedback on current knowledge and strategies of thought (p. 360).

Passini and Proulx (1988) conducted a comparative study between congenitally blind people and sighted people, aiming to gain insight into orientation and wayfinding processes for people with low vision. The results of this study suggested that people who are blind/partially sighted have the ability to represent space mentally (Passini & Proulx). The findings of the study revealed that congenitally blind people formulated decision plans—sequence of actions required for the decision-making and decision-execution processes—that were similar in nature to the plans ideated by sighted people. They differed in the sense that blind people prepared the journey in more detail, making more decisions than the sighted group, and that they relied on perceptual stimuli that were not necessarily visual to compensate for the lack of distant cues (Passini & Proulx).

The results of the study conducted by Passini and Proulx (1988) also suggested that blind people were able to build spatial representations of the navigated area. These representations, although not visual, allowed them to perform spatial tasks comparable to those performed by sighted people (Passini & Proulx). Passini and Proulx's findings supported Fletcher's difference theory, by reporting that participants who were blind used different techniques than sighted participants for spatial orientation and navigation, yet they achieved similar results.

In their book *Orientation and mobility techniques, a guide for practitioners*, Hill and Ponder (1976) described the cognitive process involved in orientation and mobility as a cycle of five steps. These steps could overlap, and may

follow an iterative path according the needs of the user (See Figure 5). The five-step process was described as follows (Hill & Ponder):

1. *Perception*: assimilating data from the environment.

2. *Analysis*: organizing the perceived data.

3. *Selection*: choosing the analyzed data that best fulfills the orientation needs.

4. *Plan*: designing a course of action based on the selected data.

5. *Execution*: performing the planned course of action.

It is interesting to observe that the five-step process described by Hill and Ponder (1976), presented the same concepts introduced by Arthur and Passini (1992) for their wayfinding theory—decision making, decision execution and information processing—although following a different structure, to privilege environmental perception and decision making over the execution of the course of action. In addition, the process described by Hill and Ponder is reversed in comparison to Arthur and Passini's, because the information from the environment needs to be acquired prior to, and not during, the execution of the task. This could be attributed to the fact that people who are blind/partially sighted require more planning than sighted people to navigate efficiently and safely, to compensate for their sensorial limitations (Passini & Proulx, 1988).

Figure 5. Five-step cognitive process for mobility

Adapted from Hill and Ponder (1976, p. 4).

5. Execution

1. Perception

4. Plan

3. Selection

2. Analysis
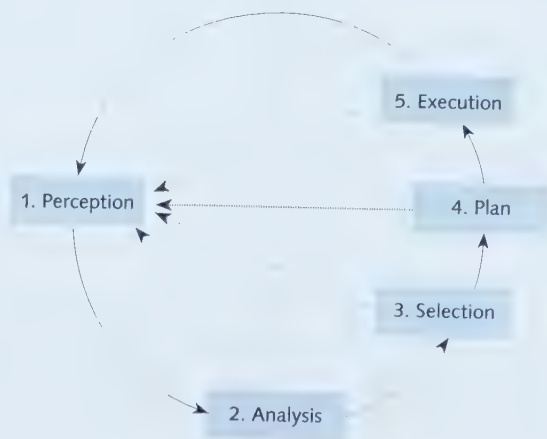
Principles of orientation for people with low vision

For people who are blind/partially sighted, competence in developing an awareness of their surroundings requires concentration and practice, which should be obtained after a period of training (Hill & Ponder, 1976). Users who have developed the skills necessary for orientation will have the ability to relate to the environment in a meaningful way and navigate through it (Hill & Ponder).

Hill and Ponder (1976) explained that the orientation process requires the user to "be capable of integrating the sensory data he receives from the environment into patterns of movement behaviors that achieve desired objectives" (p. 3). Orientation will provide meaning to the users' movements (Hill & Ponder). According to the authors, the principles for orientation rely on three basic questions that need to be answered:

- Where am I?
- Where is my objective?
- How do I get there?

The authors explained that to answer these questions, blind/partially sighted users need to go through the first four steps of the cognitive process for orientation and mobility; once the basic questions are answered, users would be able to perform the sequence of actions necessary to reach their destination (Hill and Ponder, 1976).

Empirical investigation has demonstrated that a range of features, present in the surroundings, can be identified using touch, sound and smell (Gardiner & Perkins, 2005). According to Hill and Ponder (1976), blind/partially sighted people rely on several techniques and environmental elements to follow the cognitive process and achieve successful orientation and mobility, which are known as *components of orientation*. Currently, orientation and mobility trainers working at the CNIB use these components when training new users on how to navigate independently (J. Brandt, personal communication, January 23, 2006). The components of orientation introduced by Hill and Ponder (1976) are:

- landmarks
- clues
- numbering systems (indoor and outdoor)
- measurement

4. Some landmarks will have a property called 'transferability'. For example, users can use water fountains or expansion joints to detect if there is a floor above (Hill & Ponder, 1976).

- compass directions
- self-familiarization

Landmarks

A landmark is any familiar object, sound, odor, temperature or tactile clue that is constant, easy to recognize and has a known, permanent location in the environment. Landmarks can be visually or cane-detectable, and need to have at least one unique characteristic to differentiate them from other objects (Hill & Ponder, 1976). According to the authors, landmarks can be used:

- to establish and maintain directional orientation
- as a reference point
- to locate specific objectives
- to orient or re-orient oneself to an area
- to align for a straight line of travel (parallel or perpendicular)
- to obtain information about a corresponding area[4]

For example, outdoor landmarks used by orientation and mobility trainers, working with students who are blind/partially sighted at the University of Alberta, include trash cans, recycling bins and benches (J. Brandt, personal communication, January 23, 2006).

Clues

A clue is any visual, olfactory, tactile or kinesthetic stimuli, which can be dynamic or static, that would give blind/partially sighted users the information necessary to determine their position or a line of direction (Hill and Ponder, 1976). In order to be recognized as clues, users need to be familiar with the stimulus and their source (Hill and Ponder). The authors explained that not all stimuli have equal value as clues, some will fulfill informational needs of the moment (dominant clues), some will be useful to a lesser degree and some stimuli will interfere with environmental perception (masking sounds).

Clues are generally numerous and readily available. According to Hill and Ponder (1976), they may be of help to:

- obtain directions
- determine one's position in the environment
- maintain directional orientation

- establish a line of direction
- locate specific objectives
- re-orient oneself to an environment
- obtain information regarding the environment
- obtain information about a corresponding area, by using transferability of clues (for example, the sound of an elevator will indicate the presence of other floors)

For example, University of Alberta students who are blind/partially sighted use clues like the sound of doors opening and closing, or the sound of traffic. (See Section 5.2, Student interviews).

Numbering systems

Indoor numbering systems are, by definition, the arrangement of room numbers within a specific building (Hill & Ponder, 1976). Outdoor numbering systems are used by towns or cities, and follow a particular logic that depends on the urban planning of the setting.

According to Hill and Ponder (1976), knowledge of the principles behind a numbering system can help blind/partially sighted users to familiarize themselves with the surroundings. A numbering system can be useful in several ways:

- assisting in more efficient location of specific objectives
- providing a base to generalize the layout of other buildings or urban environments
- assisting in the understanding of verbal descriptions for the location of specific objectives

Numbering systems are also helpful because they provide focal points, usually near main entrances, that users can use as orientation aids (Hill & Ponder, 1976).

Measurement

Measurement is the process of establishing the exact or approximate dimensions of an object or space, using a given unit (Hill & Ponder, 1976). Blind/partially sighted users can employ standard measuring tools for exact measures, as well as their own body to get approximate dimensions. Measurements can be used to determine dimensions of a specific area, establish the appropriate mobility technique for a particular setting, gain

knowledge about particular objects and the relative position and relation-ships between them, and to obtain a clear concept of the size of an object or area in relation to body size (Hill & Ponder).

Compass directions
The four compass directions are north, east, south and west. These cardinal points, spaced with 90° intervals around the circle of the compass, are con-stant and transferable from one environment to another. Hill and Ponder (1976) explained that compass directions are important for orientation and mobility because:

- they provide a way of monitoring movement and self-to-environment relationships, maintaining orientation and preventing people from getting lost
- the directions are more explicit and efficient when covering greater distances
- they are constant and provide stability, by offering a systematic means of traveling and maintaining orientation
- they can be used to describe and/or follow given routes to objectives, and also to describe a line of direction
- they can be used to establish relationships between features present at the environment and oneself, facilitating communication regarding the location of objects or places
- they help to make optimum use of landmarks or points of reference

According to Janice Brandt, Orientation and Mobility Instructor for the CNIB, congenitally blind people are sometimes reticent to learn cardinal points (personal communication, January 23, 2006). They argue the concept is not useful for them, and that they have no problems navigating following instructions such as 'turn right' instead of 'turn east.' However, as Hill and Ponder (1976) explained, compass directions can be an essential element of wayfinding systems because of their constancy and transfer-ability to all environments, providing a point of reference that will remain consistent regardless of the position of the person who is navigating.

Self-familiarization
Self-familiarization is a process that ties together the previous five com-ponents of orientation. Users who are blind/partially sighted will seldom

encounter difficulties when navigating in a familiar environment
(Hill and Ponder, 1976).

Jean Jackson, Advisor and Alternate Format Coordinator for the
Specialized Support and Disability Services (SSDS) at the University of
Alberta, explained that blind/partially sighted students need to follow a
structured training process in order to be able to navigate independently
through the University campus (personal communication, August 26,
2005). Once the student learns his/her schedule for the following term,
an orientation and mobility trainer from the Canadian Institute for the
Blind (CNIB) will determine the routes that will be safe and easy to
follow. Often, the direct, time-efficient routes do not have any landmarks
and are, therefore, not suitable for mobility, so an alternate route will be
suggested (Janice Brandt, 2006, personal communication, January 23,
2006). Once all the routes for a particular student are established, the
CNIB orientation and mobility trainer will walk with the student along
the routes, indicating all landmarks and clues available. The process is
repeated until the student becomes familiar with the route, memorizes
it, and feels confident enough to travel on his/her own. The self-famil-
iarization process may take up to a week of daily practice, depending on
the complexity of the route, the settings, and the student mobility skills
(Janice Brandt, personal communication).

4.4 Aids for people with low vision

By definition, an assistive technology device is any item, piece of equip-
ment or product system that is used to help people with disabilities to in-
crease, maintain or improve their functional capabilities (Cook & Hussey,
2002). People with low vision may move around independently solely by
using their residual sight, or by using assistive technologies, like *mobility
aids* and *orientation aids* (United Kingdom Department For Transport [UK
DFT], 1999; Leicester, 1980).

The level of mobility and independence of people who are blind/partially
sighted depends on several factors (Whitney, 2006). The responsibility
of developing the skills for independent navigation relies not only on the
abilities and level of commitment of the user and his/her orientation and
mobility trainer, but also on architects, urban planners and designers, who

play an important role as well (Whitney). According to Whitney, the following aspects should be considered as critical for achieving independent navigation:

- proper orientation and mobility training, to give users necessary skills and self-confidence to attempt a journey
- utilization of appropriate assistive technology devices or mobility aids (long canes, Electronic Travel Aids), to provide users ways to perceive the environment
- the availability of inclusive environments, with orientation aids and information systems accessible for all

Mobility aids

The different devices used by people with low vision to navigate environments are also known as mobility aids. The most common mobility aids are: canes of varying lengths, dog guides, and sighted human guide (Leicester, 1980). A fourth kind of device, known as Electronic Travel Aids (ETAs), have been developed to help detecting obstacles that might be missed by the long cane (Cook & Hussey, 2002). ETAs work as supplement rather than a replacement for traditional mobility aids (Cook & Hussey; Leicester). Like most electronic devices, ETAs may present technical limitations: some will not perform under extreme weather conditions, others will not detect clear surfaces like glass, while others will not offer protection against drop-offs (Leicester).

The *long cane* or *white cane* is the mobility aid most commonly used among blind/partially sighted people (Cook & Hussey, 2002), allowing users to move independently (Foulke, 1983). By using a cane, blind/partially sighted pedestrians are able to locate objects placed beyond arm's reach (Foulke). The cane enables people to become more mobile and travel independently through space, provides protection and travel safety, while identifying the user as a person with low vision (Leicester, 1980). The contact of the cane's tip with an obstacle ahead would allow users to make any corrections to their navigation (Foulke). In addition, blind pedestrians can use scanning techniques to ensure they walk on a portion of the path already examined by the cane (Foulke). Blind/partially sighted pedestrians need to be trained in order to use the cane, properly and safely, in settings that sometimes are confusing, complex or even dangerous (Leicester).

Leicester (1980) stressed the importance of the long cane, defining it as "the most effective and efficient mobility aid yet devised" (p. 359). Leicester explained the functionality of the cane as follows:

> The scanning system in which the user operates the cane supplies echo-ranging cues and force-impact data that give vital information about immediate environment. It informs the traveler about the nature and condition of the surface underfoot, gives sufficient forewarning of downsteps or dropoffs to prevent falls or injury, and protects the lower part of the body from collision. (p. 359)

The capacity of the long cane to detect the surface underfoot makes it particularly useful for settings that use tactile paving surfaces as an orientation aid (Leicester, 1980). Canes are also used by blind/partially sighted pedestrians to detect paths, objects or surfaces' edges—a technique called trailing (Hill & Ponder, 1976). Trailing can help users to keep a straight line of direction, to locate a specific objective, and to keep them aware of their position in space by maintaining a permanent contact with the environment (Hill & Ponder).

Long canes are helpful and their proper use would provide blind/partially sighted pedestrians numerous benefits. The primary advantages of the cane are the low cost and ease of use (Cook & Hussey, 2002). The long cane is reliable, long lasting, and performs reasonably well under adverse weather and temperature conditions (Leicester, 1980). In a personal communication, Jean Jackson, Advisor and Alternate Format Coordinator for the Specialized Support and Disability Services (SSDS) department at the University of Alberta, explained that the majority of U of A students who are blind/partially sighted use the long cane as mobility aid (August 26, 2005).

Cane limitations relate to the restricted range for obtaining information—an arc approximately one step in front of the user (Cook & Hussey, 2002; Leicester, 1980). In addition, the cane will not detect obstacles above waist level, and objects at knee level may not be sensed either (Cook & Hussey; Leicester).

5. Accessible Pedestrian Signals
   (APS): a device that com-
   municates information about
   pedestrian timing in
   non-visual format, such as
   audible tones, verbal mes-
   sages, and/or vibrating
   surfaces (Barlow, Bentzen &
   Tabor, 2003, chap 1, p. 2).

Orientation aids

Orientation aids are meant to facilitate independent traveling for blind/
partially sighted people by developing or enhancing their understanding
of spatial relationships, facilitating their comprehension of a specific set-
ting, assisting with the planning or memorization of a route, and providing
information about the environment (Bentzen, 1980). Some examples
of orientation aids include tactile paving surfaces, tactile maps and
accessible signage.

Tactile paving surfaces

Tactile paving surfaces are an orientation aid used in several countries,
to communicate important information such as hazard warnings, the
direction of a pathway, or the presence of amenities, to blind/partially
sighted pedestrians (UK DFT, 1999). Pedestrians who are blind/par-
tially sighted could actively make use of tactile information underfoot
when navigating the environment (UK DFT).

Japan was the first country to use warning and guidance surfaces, to
provide information about location and direction, in 1967 (Bentzen,
2004). In the report *Accessible Pedestrian Signals: synthesis and guide to best
practice,* Barlow, Bentzen and Tabor (2003) stated that tactile paving
surfaces, such as bar tiles and dot tiles, are extensively used in Japan
to indicate pedestrian crosswalks (see Figure 6) and the presence of
Accessible Pedestrian Signals.[5] However, the dimensions and locations

Figure 6. Use of raised bars and blister surfaces at a Japanese pedestrian crosswalks
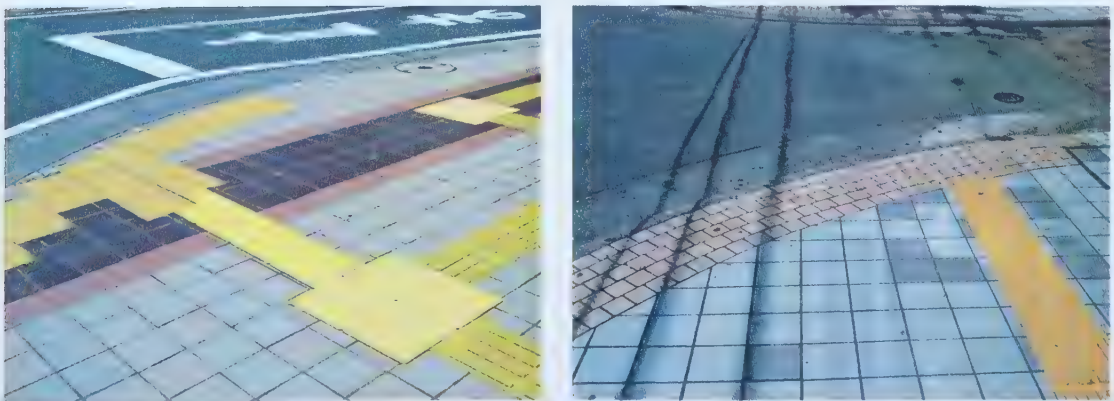
From Bentzen (2004, pp. 3, 5).

for the tactile surfaces installed in the past were not based on research, and there were no standard for production (Bentzen, 2004). Dots and bars are hard to discriminate for pedestrians who are blind, who tend to confuse one kind of tile with the other (Bentzen). To solve this problem, in the last ten years Japanese researchers started to conduct pertinent studies in order to standardize the use and design of these textures (Bentzen).

The use of blister or truncated domes as a warning texture for pedestrian crossing points is an established system used by the United Kingdom Department for Transport (UK DFT). Red and yellow blisters with a flat top are used to indicate controlled and uncontrolled crosswalks respectively (see Figure 7). In addition, the DFT published a document providing guidelines for the use of seven tactile surfaces (see Figure 8), explaining that each surface should be exclusively applied for its intended use and consistently installed, in order to ensure the comprehension of the information it provides (UK DFT, 1999). According to the UK DFT publication *Guidance on the use of tactile paving surfaces*, the textures used in the UK are:

1. *Blister surface*, for pedestrian crossing points.

2. *Corduroy surface*, with bars running across the direction of pedestrian travel, to warn people with low vision about the presence of specific hazards, such as steps. The message is to proceed with caution.

3. *Off-street platform edge warning surface*, to warn blind/partially sighted people of the edge of all off-street railway platforms.

4. *On-street platform edge warning surface*, to warn blind/partially sighted people they are approaching the edge of an on-street Light Rapid Transit (LRT) platform.

5. *Shared cycle pathway/pedestrian footway surface*, and central delineator strip. The purpose of this tactile surface is to indicate to people with low vision the location of the footpath. The central delineator is normally installed along the length of the route, dividing the pedestrian from the cyclist side, helping blind/partially sighted pedestrians stay at the footpath side.

Figure 7. Use of red and yellow blisters at pedestrian crosswalks, London

Controlled pedestrian crosswalk. Photograph: Ximena Rosselló

Uncontrolled pedestrian crosswalk. Photograph: Ximena Rosselló

6. *Guidance path surface*, to guide people with low vision along a route when the traditional cues, such as curbs or pathway edges, are not available. It can also be used to guide people around obstacles, and to indicate the way to a specific location. The surface was designed to be foot and cane-detectable, and consist of a series of raised, flat-topped bars running in the direction of pedestrian travel. At intersections, the guidance path surface should be installed with the bars running across the line of direction, to indicate to pedestrians a choice of routes.

7. *Information surface*, to help people locate amenities (i.e. telephone booths, ATMs, toilets). The information surface does not have a raised profile, but it should feel slightly softer underfoot than conventional paving materials. The surface must have a matt finish, to prevent glare, and be slip-resistant. Rubber materials with contrast colours are recommended.

Tactile paving surfaces are meant to be cane and foot-detectable, however, the ability to detect different textures underfoot varies from one individual to another (UK DFT, 1999). Certain medical conditions, such as diabetes, may reduce sensitivity in users' feet (UK DFT). Hence, it is important to use tactile textures raised enough to be detectable by most people, but without constituting a trip hazard or causing extreme discomfort (UK DFT). The research conducted by the UK DFT, led to

Figure 8. Textures with raised profiles, used by the UK Department for Transport (plan and section views)

Raised bars

Blister surface

Corduroy surface

Off-street platform edge

On-street platform edge

Shared cycle pathway/pedestrian footway and central strip

Guidance path surface

the development of tactile paving surfaces accessible for a wide range of other disabilities, including wheelchair users and people with walking difficulties (UK DFT).

The UK Department for Transport explained that it is important to consider that blind/partially sighted users may need special guidance on how to distinguish different paving surfaces, because the effectiveness of other senses, like touch and hearing, are not increased when the sight is lost. For example, the orientation and mobility training that blind/partially sighted people receive at the UK includes instruction in the interpretation of tactile paving surfaces (UK DFT). However, trained pedestrians may forget the meaning assigned to the surfaces. In a personal communication, Chris Fielding, Training Consultant for the Royal National Institute for the Blind (RNIB) Joint Mobility Unit (JMU), explained that people are not always capable of remembering the significance of the different textures (December 12, 2005). According to Fielding, in some cases, users with low vision who had forgotten the meaning of the textures react to a different surface as an indication of warning, acting cautiously at the correspondent area (personal communication).

The UK DFT (1999) stated that visual contrast, in colour and tone, should also be used to accentuate the presence of different paving surfaces. This would enable many people to use their residual vision, in addition to tactile perception, to perceive the different surfaces (UK DFT). In the document *Guidance on the use of tactile paving surfaces*, colours mentioned include yellow, for uncontrolled crosswalks, and red for controlled crosswalks exclusively. Specific colour guidelines for other textures were not provided (UK DFT).

Tactile surfaces are used in North America as well. In 1990, the United States (US) Department of Justice and Department of Transit published a set of standards, the *American with Disabilities Act* (ADA), as a legal document to protect the civil rights of persons with disabilities (United States [US] Access Board, 2006). The ADA provided design criteria for the construction and alteration of facilities, in order to ensure accessibility to places of public accommodation and commercial services; however, this document did not include design guidelines (US Access

6. *Barrier-free* refers to the at-
tribute of buildings and other
facilities in order for them to
be accessible for people with
a wide range of disabilities,
which could be physical or
sensorial (CSA, 1995).

Board, 2006). For this reason, the US Architectural and Transportation
Barriers Compliance Board (known as US Access Board) developed
the ADA Accessibility Guidelines (ADAAG), a set of specifications to
achieve and maintain accessibility, including technical assistance and
training on these guidelines. The ADA Accessibility Guidelines served
as the basis of standards issued by the US Department of Justice and the
Department of Transit to enforce the law (US Access Board, 2006).

One of the components addressed by the ADA Accessibility Guidelines
is *detectable warning on walking surfaces,* tactile paved surfaces that consist
of truncated domes of 23 mm diameter, 5 mm height and a center-
to-center spacing of 60 mm (US Access Board, 2002). The ADA
Accessibility Guidelines also established that the paving material must
contrast visually with adjacent surfaces (US Access Board, 2002).
Detectable warnings can be used indoors as well, where they must differ
from other walking surfaces in resiliency or sound–on–cane contact
(US Access Board, 2002).

In 1990, the Canadian Standard Association (CSA) published a set of
standards containing requirements to make buildings and other facilities
barrier-free[6] and accessible for people with a wide range of disabilities
(Canadian Standard Association [CSA], 1995). This document, entitled
Barrier-free design, resulted from a consensus of a Committee represent-
ing a broad spectrum of interests, and has been approved as a National
Standard of Canada by the Standard Council of Canada (CSA, 1995).
The *Barrier-free design* standards describe guidelines that could be applied
to the design and construction of facilities, or to modify existing ameni-
ties, yet they do not explain how to apply these recommendations tech-
nically (CSA). The *Barrier-free design* standards provide recommendations
to achieve a minimum level of accessibility, but do not have the force of
law, unless mandated by legislation or called up in the regulations of the
authority having jurisdiction (CSA).

The *Barrier-free design* standards requirements for tactile paving surfaces
refer to the use of *detectable warning surfaces* only, which should be
installed at the top and landing of staircases, covering the full width of
the stair for a depth of at least 900 mm (CSA, 1995). As for the paving

surface material, the CSA did not specify the profile or layout for the texture, but included two recommendations:

1. The detectable warning surface should contrast in colour with the surrounding flooring material.

2. The surface needs to be of a different texture from the surrounding flooring material.

Parallel to the *Barrier-free design* guide, the Canadian National Institute for the Blind (CNIB, 1998) described detectable warning surfaces as a texture that can be felt underfoot or detected by a person using a long cane. In their publication *Clearing our path, accessibility recommendations for the built environment*, the CNIB defined detectable warning surfaces as a device that "alerts a person who is visually impaired to a hazard, such as the start of a down staircase or the edge of a platform at the subway station" (p. 23). The CNIB explained that a frequently used detectable warning surface consists of "raised, truncated domes that are spaced 60 mm apart from the centre of one dome to the centre of another. The domes are less than 23 mm wide and 5 mm high" (p. 23). The CNIB recommended using detectable warning surface consistently for each particular building features. For example, the surface used to indicate descending staircases should be used for all descending staircases, but should be different from the surface used to indicate a platform edge (CNIB). The CNIB guidelines did not include information regarding other tactile surfaces for users who are blind/partially sighted, like a guidance texture, or information texture.

Tactile maps

Maps represent environmental information in highly encoded form (Pick & Lockman, 1983). In many ways, they keep a formal similarity to the thing they represent, although that resemblance is to some extent reduced because of the codification of the information (Pick & Lockman). In their article *Map reading and spatial cognition*, Pick and Lockman explained that maps utilize conventional symbols for representation, which can be arbitrary (i.e. dots for cities, stars for capitals, etc.) or maintain projective similarity with the object they represent (cross for church, plane for airport, etc.).

Sighted people have used maps extensively to learn new environments, make travel decisions, and understand shapes and spatial relationships of environments that are too large to be perceived (Andrews, 1983). It is common to think that maps are visual abstractions of physical settings, but the use of tactile maps have demonstrated that non-visual abstractions are also possible (Andrews). In the study *Spatial cognition through tactual maps*, Andrews examined how tactile maps are useful for blind/partially sighted people to organize internal spatial images and form spatial concepts. Andrews also classified various types of tactile maps according to their functionality, explaining that their proper use could improve cognitive imagery for people with low vision.

Mobility maps are graphic aids used for spatial orientation and navigation, displaying elements such as location of buildings, streets, walkways, obstacles and specific landmarks (Andrews, 1983). Using tactile mobility maps prior to navigation task would provide a mental image facilitating the travel experience for people with low vision (Andrews). Pick and Lockman (1983) explained that mobility maps involve more concern for metric information and less concern for geographical features, because they are produced for wayfinding purposes. Given that the main objective for mobility maps is to communicate how to get from point A to point B, general topography of a setting may be relatively unimportant, while specific routes and possible alternate paths acquire more significance (Pick & Lockman). Tactile mobility maps are often produced by request, including specific landmarks and other physical features that would be familiar and meaningful for the user, fulfilling his/her particular orientation needs (Eriksson et al., 2003).

General reference maps or *orientation maps* are used to portray general information about immediate surroundings (Andrews, 1983; Rowell & Ungar, 2003). They are used to understand location of larger environments such as buildings, urban areas, states, countries, or the world (Andrews). They provide regional and global structure for understanding geographic information (Andrews).

The design process of a tactile map needs to follow a set of guidelines that is unique for this kind of informational system, and will encounter two types of problems: choice of production process and

7. In visual communication de-
sign, legibility is understood
as the visual clarity of a text,
which is usually based in type
size, contrast, and spacing of
the characters used (Lidwell,
Holden & Butler, 2003).

For tactile graphics, legibil-
ity corresponds to the tactile
clarity of the object. A legible
tactile graphic will be easy to
interpret by tactile means
(Eriksson & Strucel, 1995).

users' legibility[7] requirements (Eriksson, Jansson & Strucel, 2003).
According to Eriksson et al. (2003), tactile maps may require certain
simplification and adjustments in order to enhance legibility issues:

> In most cases, a tactile map utilises information provided by
> a visual map of the same area, but this information has to be
> translated into a form suitable for the tactile sense. When this
> translation is made the similarities and differences between
> the two senses should be taken into consideration. The basic
> change is that variations in brightness and colour on the visual
> map have to be substituted by changes of elevation over the
> background, thus in relief, on the tactile map in order to be
> picked up by the fingers. (p. 50)

There are some similarities between reading a map using vision or
touch: both senses can perceive information regarding forms, edges,
textures, sizes and spatial location; however, small details that would be
perceivable by vision cannot always be detected by touch (Eriksson et
al., 2003). To provide users with legible and meaningful information,
scale may need to be altered for tactile maps (Bentzen, 1980). Bentzen
explained that, in some cases, schematization of the represented setting
would be more important than accuracy of scale and direction, in order
to make the information legible by touch (see Figure 9).

Scale and schematization should be conditioned to a level of graphic
abstraction that is meaningful to the user (Bentzen, 1980). Eriksson et
al. (2003) explained that it is also important not to include too many
details. By removing unnecessary information, and simplifying the
layout as much as possible without losing any essential data, tactile maps
would be easier to read and more legible (Eriksson et al.). In addition to
legibility issues, one particular problem encountered when perceiving
a tactile map by haptic means is the difficulty of getting an overview
of the setting (Eriksson et al.). Eriksson et al. explained that to get an
integrated perception of a tactile map that is only partially perceived
each time is a challenge. Ways to compensate for the lack of an instant
overview should be provided, like verbal descriptions or general instruc-
tions about how to read the overall picture (Eriksson et al.).

Figure 9. Map of Brandeis University Campus, and its schematical expression for tactile representation


Regular map
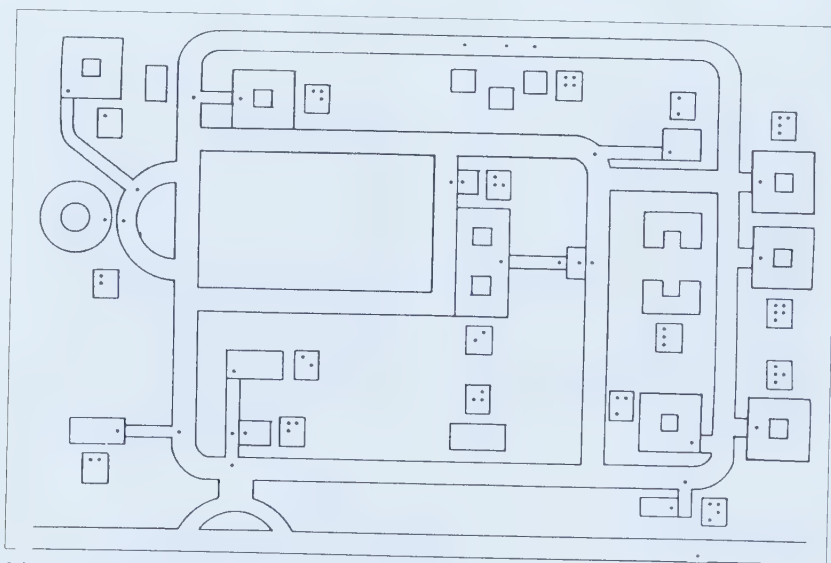
Schematic representation for tactile map, by R. Amendola.
From Bentzen (1980, pp. 304–305).

Currently, two tactile maps of the University of Alberta campus are available for students who are blind/partially sighted:

1. A portable mobility map produced using thermoform, a vacuum-formed technique (see Figure 10). It was observed that the portable map presented some cluttered information. The map consists of two sections, embossed in separate sheets of paper 11 x 11.5", one shows the area north of 89th avenue, the other shows the area south of 89th avenue. In addition, a legend was printed in Braille.

2. A wall-mounted general reference map that was installed in a display case, behind a glass. It presents a large amount of information and details that could be perceived as cluttered by tactile means. The compass is rotated, presenting the north on the right side of the compass instead of at the top (see Figure 11), which equals west when the user is facing the map. According to Jean Jackson, the map is scarcely used by students with low vision (personal communication, July 11, 2006).

Figure 11. University of Alberta portable tactile map

Section 1: north of 89th avenue

Section 2: south of 89th avenue
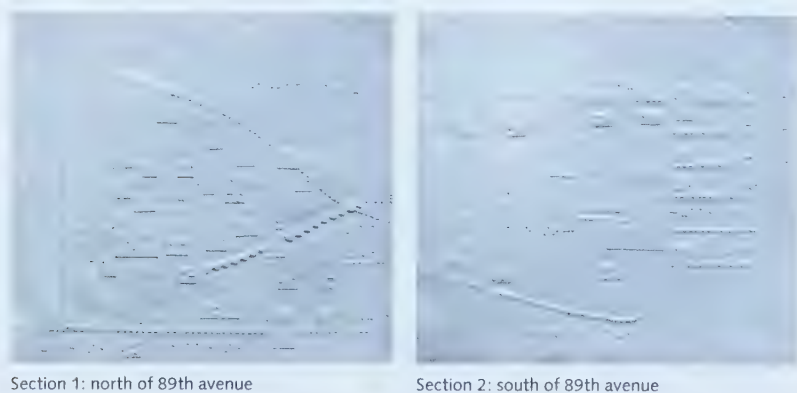
When consulted about the usefulness of mobility tactile maps as an orientation aid, University of Alberta students who are blind/partially sighted stated that, in general, they do not use tactile maps regularly, because they are difficult to read and understand. Students also stated that, typically, the layout of the tactile maps does not fit their mental

8. June Fraser, current Director of the UK Sign Design Society, has been involved with the British Standards Institute on symbols and signs for people with special needs. Peter Barker, a founder of the Joint Mobility Unit (JMU) of the Royal National Institute for the Blind (RNIB), is also a member of the Sign Design Society. (Barker & Fraser, 2000).

image of the setting, a fact that makes navigation harder. Some students reported that, in the particular case of the U of A campus maps, they preferred not to use them because the information presented there is outdated. They also mentioned that, for the wall-mounted map, having the north on the right side of the compass was confusing (see Section 5.2, Student interviews).

Tactile signage

Peter Barker and June Fraser[8] (2000) published a set of guidelines for accessible signage entitled *Sign design guide, a guide to inclusive signage.* According to Barker and Fraser (2000), a sign is an orientation aid designed to convey information about direction, location, safety or a form of action. Signs are more relevant to people who are unfamiliar with the surroundings, and specially important for people who need to know how to do something, like finding the fire exit, or operating a door entry system (Barker & Fraser). A person who is reading a sign might be anxious, and if he/she has low vision, the difficulty for locating and understanding the sign may increase (Barker & Fraser). Barker and Fraser explained that signs must be clear, concise and consistent, "A successful sign system should minimize such anxiety and confusion. It should be easy to understand and people with a visual impairment should not be placed at a disadvantage" (p. 21).

Figure 10. University of Alberta wall-mounted tactile map
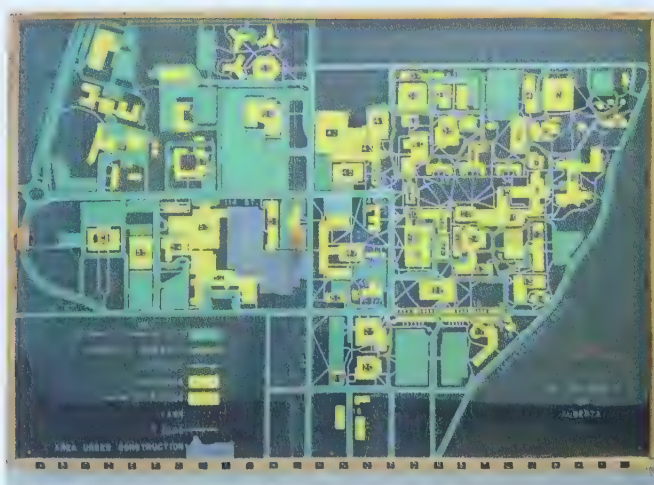
Barker and Fraser (2000) classified signs into four categories according to their functionality:

1. *Information signs* are used for orientation purposes; they include signs to identify main locations inside buildings, directories, maps and plans.

2. *Direction signs* are used to direct users to specific locations, using arrows and text.

3. *Identification* or *location signs* are installed at individual locations, to indicate the presence of a facility, service, room or a person's office—because they are located at the actual destination, they do not use arrows.

4. *Safety signs*, which can be either warnings or prohibition signs, are aimed at preventing users from hazard.

As mentioned before, most people with low vision will have some useful sight (Royal National Institute for the Blind [RNIB], 2002). Blind/partially sighted users may be able to distinguish colours, shades of light, text printed in a large size, and will benefit from a well designed signage system (RNIB). However, for totally blind people, and users who do not have enough vision to distinguish printed information, tactile signs are essential (Barker & Fraser, 2000; RNIB). Information could be presented in visual and tactile formats, incorporating embossing techniques for symbols and large texts, as well as Braille (Barker & Fraser; RNIB).

Braille, a tactile communication system to be read by touch, consists of combinations of six raised dots, arranged in two columns of three dots (RNIB, 2002). Each dot has a number assigned, to help with the memorization of each combination (see Figure 12). The layout of the dots, also known as the *Braille cell*, has a standard size and structure that must not be altered (Barker & Fraser, 2000; RNIB). The 63 possible dot combinations correspond to the letters of the alphabet, punctuation marks, letter groups or words, mathematics, scientific equations, computer notations, music, etc. (CNIB, 2006d; RNIB). Braille is mostly used by people with little or no residual sight, although only about 20 per cent of people with low vision are able to use Braille (RNIB).

Figure 12. Structure and layout of Braille cell

Braille cell,
real size

the letter 'a' is represented
by embossing dot number 1

There are two grades of Braille:

1. *Grade 1 Braille*, a letter-by-letter transcription of words, is often used for the first stage of learning to read Braille (Barker & Fraser, 2000; RNIB, 2002). Grade 1 Braille generates bulky texts; one Braille cell will be 3.7 mm wide by 7.2 mm high (Barker & Fraser), which could be compared to a text set in Arial 28 point size.

2. *Grade 2 Braille* uses dot combinations as abbreviations, to represent common letter groups such as 'the' and 'for' (RNIB, 2002). Is often used for complex documents and for tactile signs (Barker & Fraser, 2000; RNIB, 2002). Grade 2 Braille may be appropriate for longer instructions and site descriptions (Barker & Fraser, 2000).

The *Sign design guide* (2002) as well as the RNIB See it right pack (2002) provided a set of guidelines for the design of accessible signage systems, which are summarized below:

a. *Sign location and material*

   Installation of signs should be consistent, using the same height for all signs with the same function (e.g. all identification signs with room numbers should be at eye level, on the wall adjacent to the latch side of the door).

   Signs should be wall-mounted and placed at eye level, with a bottom height of 1.400 mm and a top height of 1.700 mm, if possible. Suspended signs are not recommended, because they represent a potential hazard to users if hung too low.

Tactile signs should be positioned where they can be easily touched. A slight incline will provide a natural position for the hand, facilitating tactile reading.

Locations for the signs should not present obstructions. Matt-finished materials, and an adequate lighting system, should be used to provide enough light without causing glare.

b. *Sign content*

A hierarchical system should be used when multiple messages need to be present on a sign; several small groups of information would be easier to read than one large list.

For identification signs, numbering systems should be simple, concise and used consistently throughout the setting. Numbers can also be helpful because, for blind/partially sighted people, recognizing them can be easier than reading names, and numbers can be larger than text without occupying too much space

Accessible signage should also incorporate non-visual features—such as tactile symbols, embossed text, Braille text, and audible information—in order to make the information accessible for users who are totally blind.

c. *Sign layout*

Sans serif typefaces are recommended; serifed typefaces are not suitable for embossed texts, because the serifs may be too small as to be reproduced accurately. The use of uppercase and lowercase letters is recommended, to provide text legibility.

Colours should be used to increase contrast of the sign against the environment, and of the text against the background; colours could also help to identify groups of signs that are related (e.g. colouring brown all identification signs for administration department). The use of white letters over dark background is suggested to improve legibility and contrast, and to minimize glare.

Recognizable symbols are particularly useful for people with low vision, and they can be larger than the equivalent text message. In addition, tactile symbols would be accessible for totally blind people.

Braille text of standard size should be incorporated, located below
the text and aligned left; grade 2 Braille is acceptable for long texts.
Locators for Braille texts, along the left edge of the sign, indicating to
totally blind users where to start reading (see Figure 13).

Figure 13. Standard size for Braille text and locators

Braille cell   Locator
From Barker and Fraser (2000, p. 47).
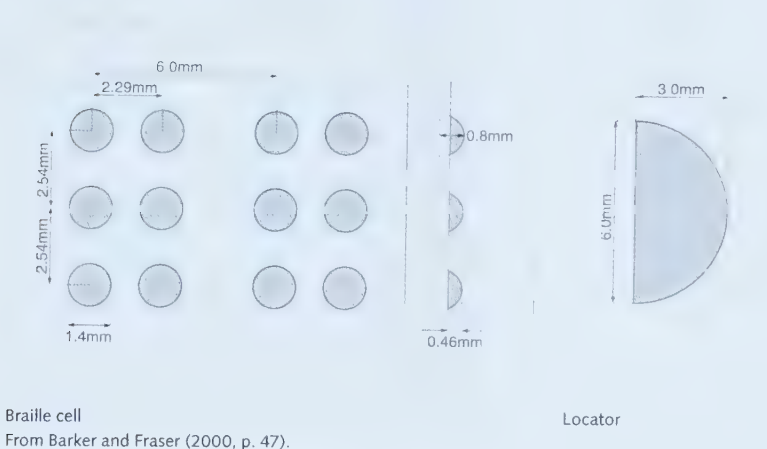
Tactile information should be embossed, not engraved or debossed,
to ensure tactile perception.

An accessible signage system is used by the RNIB at their main office
in London, UK, to ensure the information is accessible for all clients.
Information is presented in visual and tactile formats, keeping a consis-
tent structure for all the signs (see Figure 14):

• at the top, a visual/tactile symbol is located, followed by embossed
  large format text

• a separated section with Braille text is consistently placed at the
  bottom of the sign

• the two sections are indicated by an indent and by a different colour
  background, although they do not have Braille locators to guide users
  to the Braille text

Figure 14. Example of a visual/tactile sign, RNIB main office, London

4.5 Design of legible text for people with low vision

The visual conditions, capabilities and limitations of any audience will vary according to each individual situation. Some people will be sighted, some will have low vision, and some people will see nothing at all (RNIB, 2002). People may be congenitally blind, whereas many other lose their sight when they are older (RNIB). When a piece of information is designed following an inclusive design approach—that is, taking into account all levels of vision—everyone would benefit (Barker & Fraser, 2000; Evamy & Roberts, 2004).

Several studies, regarding legibility for blind/partially sighted users, have been conducted in the past years by organizations such as the CNIB, the RNIB, and Lighthouse International. The intention of these studies was to distill a set of guidelines to be followed, providing recommendations on how to design texts accessible and legible for people with low vision, as well as to advocate for a design practice that considers a broader audience. Two design approaches for the production of printed materials, that take

into account the needs of users with low vision, are *large print* and *clear print* formats (RNIB, 2002). Large print documents are produced in a large type size, ranging from 16 to 22 point size (RNIB). Clear print text differs from large print in the size of the type, using a minimum of 12 point, although 14 point is recommended to reach a broader range of users (CNIB, 2006a; RNIB). Clear print and large print formats are more than just a range of type size; they also address the choice of typography, font style, letterspacing, leading and colour, creating information that will be accessible for a wider audience (CNIB, 2006a; RNIB)

Type structure

A pertinent study, regarding legibility for blind/partially sighted people, revealed that people who were born with low vision find sans serif typefaces easier to read, whereas people who became blind/partially sighted over time prefer serifed typefaces (Prince, 1967). However, several relevant studies conducted in the past years (Arditi, 2003; Barker & Fraser, 2000; CNIB, 2006a; Hartley, 1994; RNIB, 2002) suggested that sans serif typefaces, like Helvetica, are easier to read for people with low vision.

Type style

Relevant studies revealed that a roman typeface would be more readable than italics, oblique or condensed styles for people with low vision (Arditi, 2003; CNIB, 2006a; RNIB, 2002). In addition, it was suggested that the use of both uppercase and lowercase letters would help with the recognition of the shape of words (Arditi; CNIB; RNIB).

Typefaces with thin strokes, and light versions of fonts, should be avoided because they may not be perceptible for blind/partially sighted people (CNIB, 2006a). Bold typefaces are recommended for reversed text, because white text on dark background tends to appear smaller (RNIB, 2002).

Letterspacing

Text with little space between the letters may be difficult to read for people who are partially sighted, especially those with limited central visual field (Arditi, 2003). According to Arditi (2003) and the CNIB *Clear print: accessibility guidelines* (2006a), letterspacing should be wider than normal to ensure legibility. It was also suggested that monospaced fonts

would be more legible for readers with limited central visual field, because these typefaces have a wide letterspacing (Arditi; CNIB, 2006a).

Leading

For blind/partially sighted people, it might be difficult to distinguish between one line and the next if there is not enough leading or space between the lines (Arditi, 2003; CNIB, 2006a; RNIB, 2002). Leading of at least 25–30% of the text point size is recommended (CNIB; RNIB). Bold fonts may require more leading to be legible (CNIB).

Colour

Text should be printed with the highest possible contrast with the background (Arditi, 2003; CNIB, 2006a; RNIB, 2002). There is evidence that for many readers who are blind/partially sighted, light (white or light yellow) letters on a dark background are more readable than dark letters on a light background (Arditi; CNIB). Using reversed type helps with legibility, because it reduces the amount of glare on the page (RNIB).

According to Arditi (2003), in general, printed material is most readable in black and white, because it is difficult to achieve high contrast with other colour combinations.

4.6 Accessibility policy at the University of Alberta

The idea of applying a barrier-free design at the University of Alberta dates back to the late 1970s (University of Alberta Specialized Support and Disability Services [SSDS], 2005). In 1980 the Specialized Support and Disability Services (SSDS) was established; since then, the University has consulted with SSDS to review priorities for accessibility related renovations (University of Alberta SSDS). The University of Alberta Accessibility Advisory Committee (AAC) was established in 1993 to convey the input of students and staff regarding on-campus accessibility issues, in order to present it to Physical Plant (University of Alberta SSDS). The Accessibility Committee is constantly advocating for the achievement of accessible environments at the University of Alberta. For example, working with University Occupational Therapy students, the Accessibility Committee surveyed the campus determining the need of specific accessibility projects (i.e. improve lighting, washrooms, building ramps etc.) and the priority of these projects (University of Alberta SSDS).

At the time this research was conducted, the AAC was assisting the University of Alberta Capital and Strategic Planning Services (CSPS) Branch, with the collaboration of Ron Wickman Architect, to develop a set of standards for universal access at the University of Alberta campus, entitled *Universal design guide* (University of Alberta, n.d.). This guide, although close to completion, is currently a work in progress.

5. DESIGN INVESTIGATION

To ensure a user-centered approach, a series of studies were conducted after the background research, which involved the participation of blind/partially sighted at the University of Alberta. The objectives of these investigations were to amplify the knowledge of the target audience, and to discern specific issues regarding on-campus navigation.

5.1 Definition of target audience

The definition and understanding of the needs of all possible users was essential to ensure the accessibility of the orientation system. In order to comply with inclusive design principles, it was necessary to take into account all levels of sight into the design process.

The target audience for the proposed orientation system involved all University of Alberta students, including people with normal vision as well as blind/partially sighted, aiming to achieve accessibility for all. However, due to the limitations of this Master's thesis project, the student interviews and the benchmarking task only included users that are blind/partially sighted.

5.2 Student interviews

To work in collaboration with potential end-users is fundamental for a user-centered design process (Frascara, 1997). To incorporate the experience and knowledge of students with low vision was considered essential for the design of the system. Strickler (1997) explained that, as a methodology for qualitative data gathering, interviews are "intended to expose how a person defines events and objects pertaining to the topic, understands his or her experiences with it, and reveals the logic by which decisions and choices are made" (p. 50). Interviews can help elicit information about user preferences, impressions and attitudes (Dix, Finlay, Aboud & Beale, 1998). Based on these premises, individual interviews, with students who are blind/partially sighted, would be an appropriate way to obtain relevant information about the users' experience.

Objectives

The general objective for the interview was to determine the specific needs of blind/partially sighted students regarding on-campus mobility and wayfinding at the University of Alberta.

The interview sessions also aimed to:

- determine the major landmarks, at the University of Alberta, for people who are blind/partially sighted
- discover which environmental cues were used for on-campus navigation and orientation (i.e. physical objects, smells, sounds, etc.)
- determine the areas which are complex to navigate, and the reason for the complexity
- determine which features should be included in the physical devices comprising the system (e.g. tactile maps, visual/tactile signage, textured pathways)
- select a specific route to apply the proposed orientation system to test its performance

Participants

After the study was approved by the Arts, Science and Law Research Ethics Board, at the University of Alberta (see Appendix A, Ethics Application), twenty-one University of Alberta students, who had low vision, were invited to participate individually (see Appendix B, Interview materials). Students were contacted by e-mail through the University of Alberta Specialized Support and Disabilities Services (SSDS) Department.

Six University of Alberta students who are blind/partially sighted agreed to participate in the interviews. Of these students, two were totally blind; one was legally blind and had light perception and three participants were legally blind but had residual sight as to read text in large print format.

Procedure

Interviews were conducted using a questionnaire consisting of 20 open-ended questions and 3 multiple-choice questions, including topics such as students' on-campus mobility experience, modes of transportation used to get to the University, and potential elements to be included on the system based on the users prior experience (See Appendix B, Interview materials).

Data collection

Data was collected by recording audio. Notes were also taken by the investigator at the time of the interviews.

Analysis of collected data

Audio recordings and notes were analyzed, to distill information that would be useful for the design of an accessible orientation system. Quantitative data, although not statistically reliable, was used to elicit the University major landmarks; frequently used environmental cues; determine complex areas for navigation and features to include in the orientation system. Qualitative data explained the reasons behind the students' responses. Results and findings of the interviews were categorized and summarized as follows:

University of Alberta major landmarks

According to participants interviewed, the following University of Alberta buildings were pointed out as major landmarks used for on-campus navigation:

- Student Union's Building (SUB)
- HUB Mall
- Edmonton Transit System (ETS) Bus terminal/Light Rail Transit (LRT) station
- Education Building
- Fine Arts Building (FAB)

Reasons given for choosing these buildings were familiarity (SUB, HUB Mall, LRT station), prominence provided by their elevation (SUB, Education) and unique physical features, such as the metal sculptures near FAB.

Environmental cues used for on-campus navigation and orientation

Participants mentioned several features commonly used as cues for navigation:

- different paving surfaces: grass, gravel, cement
- pathways edges
- traffic sounds
- sound of footsteps
- specific sounds (i.e. fish pond, buildings fans)
- different smells
- slopes and inclines

Complex situations for navigation and wayfinding

At first it appeared that the interview sessions did not help to determine a specific area where an accessible orientation system would be needed the most. Totally blind students found it more difficult to navigate outdoors, whereas partially sighted students had more trouble when navigating indoors—due the lack of differentiation among the interiors of old buildings. By analyzing the common characteristics of the environments described as 'hard to navigate', it was possible to formulate a theory about the underlying issues affecting the navigation process—identifying several complex situations regarding wayfinding and navigation that could be improved by the use of an accessible orientation and wayfinding system:

- open areas without landmarks
- areas with intertwining/splitting paths (i.e. Quad area, Arts Building area)
- paths that are curved rather than straight
- paths with turns at angles other than 90°

Four areas presented the attributes mentioned above, and therefore, were identified as particularly difficult to navigate (see Figure 15):

1. North end of campus—Biological Science Building and surroundings.

2. Area between Chemical/Materials Engineering Building and Computing Science Centre.

3. The Quad area.

4. Open area between Tory Building, Arts Building and Rutherford Library.

Participants did not feel on-campus navigation was particularly unsafe, but they mentioned staircases that do not indicate the edge of the steps with a band of contrasting colour (i.e. yellow) represent a potential hazard for them.

Physical features and components of the system

All participants considered that an accessible system was necessary, and that it must be consistent in order to work. As for the physical features

Figure 15. Map of the four complex areas for navigation, identified by interviewed students

Area 1: North end of Campus, Biological Science Building and surroundings

Area 2: Chemical/Materials Engineering Building and Computing Science Centre

Area 3: The Quad

Area 4: Tory Building, Arts Building and Rutherford Library

The identified areas were located between Saskatchewan drive, 89th avenue, 116th and 112th street

that should be included in the system, the participants interviewed found the following elements potentially useful (see Figure 16):

- fixed landmarks, placed at strategic points along routes or pathways, which should be slightly different from each other, to be identified (i.e. distinguishable shape, colour, texture, material)
- compass with cardinal directions
- tactile paving surfaces with saturated, bright colours
- tactile maps of the close vicinity, showing U of A major landmarks (if designed simply and with clarity)
- directions to the major landmarks, both in Braille and large print format

It is important to note that participants who were totally blind reported tactile maps were often too complicated to be understood by tactile means. They also stated that the University of Alberta tactile maps currently available hinder, rather than facilitate, the navigation process.

Figure 16. Usefulness of features proposed for the orientation system, according to interviewed students

▶ Indicates features considered useful by four or more partici-pants. Number of participants: six

|	Yes	No	Maybe	n/a
▶ Fixed landmarks, placed in strategic points along the routes/pathways	••••••			
Tactile maps of the U of A	•	•••	•	•
▶ Textured pathways	••••	•		•
Colored pathways	•••			•••
For Fixed landmarks:				
▶ A number assigned to the landmark	•••••		•	
▶ Saturated color for the landmark	••••			••
Location of the landmark printed in Braille (e.g. 'HUB Mall')	•••			•••
Location of the landmark printed in large print	•••			•••
▶ Location of the landmark available in audible sign	••••••			
▶ Compass, visual & tactile	•••••		•	
▶ Verbal directions for next landmarks, printed in Braille	••		•	•••
Verbal directions for next landmarks, in large print	••	•		•••
A tactile map of the near surroundings	•••	•••		
▶ A tactile map, showing the predominant U of A reference points	•••••		•	

Reasons given include that, for the wall-mounted map, having the compass with north pointing to the right was disorienting for them, because it does not follow the convention of placing the north on the top of the compass. In addition, when facing the map, the direction labeled as north corresponds to west (see Figure 11, wall-mounted tactile map). They also explained that the information presented on the map was cluttered and out of date.

Selection of route

The route between Student's Union Building (SUB) east entrance and Central Academic Building (CAB) west entrance, crossing the Quad area (See Figure 17), was selected to test the performance of the proposed orientation system, for the following reasons:

1. Two out of six participants identified this route as a complicated one. A third participant had never walked that route before because, for her, the Quad is "too hard to navigate"—it is an open area with no landmarks available. The complexity of this route made it an interesting possibility for the application of the system.

2. The SUB to CAB route presents difficulties where the performance of the system could be tested, such as two four-way intersections and areas with intertwining/splitting paths (Alumni Walk, CAB entrance.

Figure 17. Route selected to test the performance of the proposed orientation system
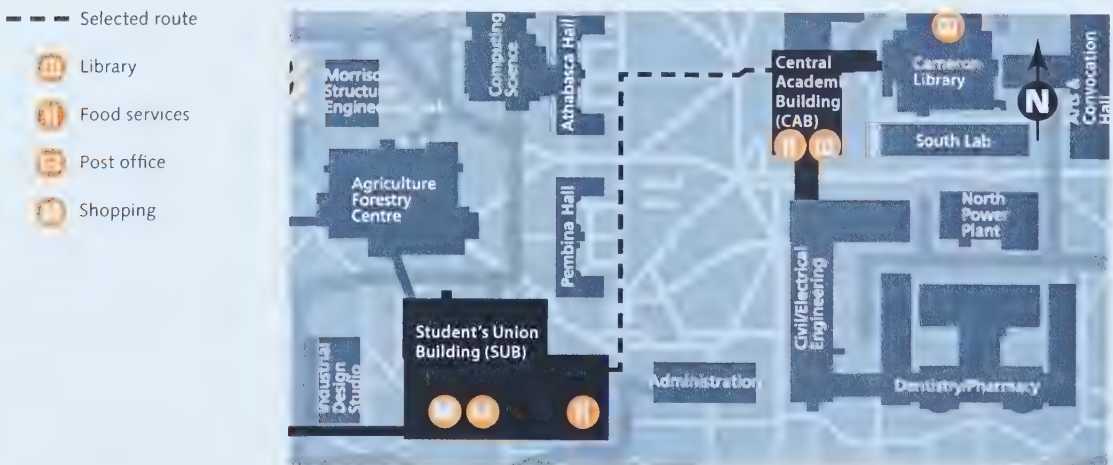
3. All participants stated that SUB is a building they visit often because the SSDS offices are located there. Likewise, CAB is a frequently visited building, which provides services, amenities and because it is connected to Cameron Library. Considering that there are presently no pedways connecting SUB to CAB, an accessible orientation system joining these two facilities could be useful for students with low vision.

Conclusions

The nature of the students' specific needs relate to the cause and level of their blindness, and the particular area of the University of Alberta through which they had to navigate the most. Each student had needs to be met, which were unique and particular to each individual. Trying to address all these needs represented a challenge for the inclusive design goal. However, once all the data collected during the interviews was analyzed, most causes of complexity and difficulty when navigating had a common source that could be addressed by an accessible system.

5.3 Benchmarking of the environment

The benchmarking task consisted of asking participating students to walk, without an available orientation system, the selected route: from Student's Union Building (SUB) east entrance to Central Academic Building (CAB) west entrance, by crossing the Quad area. The navigation process was observed, helping set parameters regarding the efficiency of the task to which the performance of the system could be compared.

This study was conducted during February 2006, when a considerable amount of snow had accumulated on the pathways. This factor provided an insight into the specific navigation problems that arise during the winter season, for students who are blind/partially sighted.

Objectives

The benchmarking procedure was conducted to determine the efficiency of navigating the surroundings, at the University of Alberta, for students who are blind/partially sighted. The findings of this phase also helped estimate how much (in terms of time management, confidence and safety issues) students with low vision would benefit from having an accessible wayfinding system.

9. Think aloud is an observational technique used for evaluation tests, were users are asked to elaborate their actions by describing what they believe is happening, why they take the actions, and what are they trying to do. (Dix et al., 1998).

Participants

After the study was approved by the Arts, Science and Law Research Ethics Board, at the University of Alberta (see Appendix A, Ethics application), twenty-one University of Alberta students, who had low vision, were asked to participate individually. An e-mail invitation was sent through the Specialized Support and Disability Services (SSDS) Department (see Appendix C, Benchmarking materials).

Five students agreed to participate. Of these students, two were totally blind and used a white cane as a mobility aid; one had light perception and used a cane as well; two were legally blind and did not use any mobility aid.

Procedure

Students were asked to walk from the east entrance of the Student's Union Building (SUB) to the West entrance of Central Administration Building (CAB). A description of the route with detectable clues and landmarks was read to participants (see Appendix C, Benchmarking materials). Due to the fact that some students were not familiar with the route, a mobility expert from the SSDS was available at a student's request. Two students asked to be accompanied by a mobility expert.

Data collection

Data was collected by recording video and audio, which was analyzed upon completion of the benchmarking phase. A hands-free recording device was given to participants at the beginning of the task; they were asked to think aloud[9] in order to record their impressions during the task. A research assistant recorded the performance of the task using a digital video camera.

Analysis of collected data

The analysis of the qualitative information obtained from the videos and audio recordings, made during the benchmarking process, provided important insights regarding the navigation and wayfinding process for people who have low vision, such as situations that might cause confusion when navigating, and aspects to consider for the design of detectable landmarks.

Areas of navigation comprised of paths going in different directions were difficult for participants to navigate. For example, when exiting the Alumni Walk, two out of five participants had problems finding the right path, taking the one that goes north-east instead of the one towards north as per instructions given at the beginning of the task (see Figure 18, next page).

Once the right pathway was found, participants using a long cane were able to use the snow piled at the sides of the pathway for trailing, maintaining a straight line of direction. This revealed that it would not be necessary to have a guidance surface along the whole route, because students can follow the grass line or the snow, depending on the season.

Participants were able to navigate the route with minor difficulties. With the exception of the Alumni Walk area, common questions from the participants aimed to confirm what they were expected to do when reaching a particular point (e.g. 'Should I turn right'?) rather than to obtain environmental information (e.g. 'Where are we now'?).

Winter conditions affected the conspicuousness of certain landmarks in several ways. For example, the height of the snow piled up at the edge of the path made the light post, placed at the turning point, hard to detect with the cane (see Figure 19). On the other hand, participants who had remaining sight benefited from the contrast created between the edges of the white snow and the dark pathway.

Figure 19. Accumulation of snow at the edge of the pathway

Base of the light post

Figure 18. Disorientation at the Alumni Walk

⟶ Path to be followed for the selected route towards CAB

···▶ Path taken by blind/partially sighted participants that became disoriented

Alumni Walk

N

Participants who were not totally blind were able to detect certain landmarks visually, such as a phone booth and a recycling bin. They explained that these objects were large and dark enough to be conspicuous for them.

Participants were able to walk the route on their own. Even students who were unfamiliar with the surrounding area did not ask the mobility expert for assistance to navigate. Two important points were elucidated from this fact:

1. It confirmed that spatial orientation and navigation are two different operations required for wayfinding (Arthur & Passini, 1992), demanding different skills to be performed. At times it was observed that participants were in fact disoriented, but they kept navigating because they did not become aware that they were traveling in the wrong direction.

2. That an accessible orientation system should not only aim to be detectable and legible in order to be effective, but should also address the issue of how to increase the confidence level of the students when navigating.

Conclusions

The findings of the benchmarking phase provided parameters to compare with the results of the prototype testing phase, to help determine if the system would prove beneficial to blind/partially sighted students. Observation of the navigation process also provided information and insight into the different techniques used for navigation and wayfinding by people who have low vision.

5.4 Guidelines for the design of the orientation system

The analysis of the student interviews provided information about complex areas for wayfinding at the University of Alberta, and also indicated which features should be included in the system to ensure it is accessible. The benchmarking task confirmed most of the observations arising from the interviews, and revealed new aspects of the navigation process, such as the importance of the confidence level for navigation. It is important to note that these findings are particular to the settings where the study was conducted, although the methodology followed for this study could be applied to other settings to gain specific information about them.

A set of guidelines for the design of the system were determined, taking into account the information obtained from the background research and the design investigation:

1. Fixed landmarks would be useful for on-campus navigation. Landmarks need to be large enough in order to be detectable visually for blind/partially sighted people.

2. A number could help with landmark identification, and with route memorization.

3. A compass, to indicate cardinal directions, could be a useful resource for on-campus orientation and navigation.

4. Maps showing only major landmarks at the U of A might be easier to understand by tactile and visual means.

5. Visual and tactile information should be provided, to ensure accessibility for totally blind students.

6. All texts should be printed in Braille and large print formats.

7. Saturated colours should be used for landmarks, to ensure conspicuousness.

8. Tactile paving surfaces that are foot-detectable as well as cane-detectable, could benefit blind/partially sighted students.

9. Coloured paving surfaces could benefit students with residual vision.

10. Guidance textures could be applied in situations where finding a pathway is difficult due to the presence of multiple or splitting paths, such as the Alumni Walk area. Its use should be controlled and spare (J. Brandt, Orientation and Mobility trainer for the CNIB, personal communication, January 23, 2006).

11. A system to indicate upcoming intersecting pathways should be used. Because of the multiple possibilities, four-way intersections are more difficult to navigate than T intersections (J. Brandt, Orientation and Mobility trainer for the CNIB, personal communication, January 23, 2006).

12. Turning points should be indicated, to facilitate navigation.

6. DESIGN RESPONSE

The information collected from the background research and the results of the design investigation, helped to determine the features that should be included in design of the system, to solve specific problems encountered by blind/partially sighted students during the navigation process. A proposal for the orientation system was developed, including the production of a prototype to test its performance.

6.1 Design of the orientation system

According to the guidelines previously distilled (see Section 5.4, Guidelines for the design of the system) the following mobility aids were considered as potentially facilitating on-campus navigation:

- tactile paved surfaces on pathways, to guide students at complex navigation areas
- fixed poles at intersections, to indicate turning points
- informational landmarks, providing visual and tactile information about the location of major University of Alberta landmarks

Tactile paving surfaces

Tactile paving surfaces are used worldwide to provide important information about the environment to blind/partially sighted pedestrians (see Section 4.4, Aids for people with low vision).

According to the UK Department for Transport, most people with low vision can reliably detect, distinguish and remember a limited number of different tactile paving surfaces by using their canes or their feet (UK DFT, 1999). The UK DFT assigned different meaning to different textures, such as blisters for pedestrian crossing points, raised bars for directional guidance, or smooth surfaces to help people locate amenities. Having different textures to communicate different messages is important in terms of usability; users need to be able to distinguish a guidance texture from a warning texture (Bentzen et al., 2000; UK DFT). A limited number of surfaces should be used to help users remember the meaning assigned to them (C. Fielding, Training Consultant for the RNIB JMU, personal communication, December 6, 2005).

Several organizations (UK Department for Transport; CNIB; US Department Of Justice) and documents advocating for accessibility, such as the US Americans with Disabilities Act (ADA) and the Canadian Standard Association's *Barrier-free design*, recognized the potential of using tactile paving surfaces as an accessible and inclusive way to provide information. At the time the research was conducted, most specifications regarding these surfaces addressed solely the production of detectable warnings (CNIB, 1998; CSA, 1995). Canadian guidelines for the design of tactile paving surfaces, other than the CNIB and the CSA recommendations for the detectable warning surfaces, were not found. The UK DFT (1999) provided standardized specifications for seven tactile surfaces (see Section 4.4, Aids for people with low vision), which were used as a guide for the design of the tactile surfaces for the accessible orientation system. When necessary, the guidelines were adjusted and customized for the University of Alberta, to be operational under harsh winter conditions.

The results of the interviews and the benchmarking process showed that blind/partially sighted students required guidance at certain areas that comprised complex navigation patterns. These problematic situations could be improved by the use of the following tactile paving surfaces:

1. A *guidance texture*, to guide users through areas with curved pathways, or areas with splitting/intertwining paths.

2. A *four-way intersection texture*, to indicate intersecting pathways.

3. An *information texture*, to indicate presence of informational landmarks.

Guidance texture

In the document *Guidance on the use of tactile paving surfaces* (1999) the UK Department for Transport explained that the *guidance path surface* (or *guidance texture)* was designed to guide people along a route; blind/partially sighted pedestrians can either walk on the tactile surface or maintain contact with the tip of the cane. In the same publication, the UK DFT made clear that the surface should be used sparingly, in order to maximize its effectiveness.

The guidance texture could be helpful if applied at the exit of the Alumni Walk area, the premise being that having a tactile indication to follow

might avoid the confusion created by the multiple paths available, guiding the students to the right pathway (see Figure 20).

According UK Department for Transport guidelines, (1999), the guidance texture consists of a series of raised flat-topped bars running in the direction of pedestrian travel, with the bars having between 5 and 5.5 mm high, 35 mm wide, and spaced 45 mm apart, in order to be detectable (UK DFT). The guidance texture approved by the ADA, similar to the one used at the UK, consists of flat-topped bars 0.3" high, 1.34" wide, and spaced 2.95" from the center.

Textured tiles, approved by the ADA, can be purchased in the United States (see foldout, Figure 21). This fact made the suggestion of using this texture at the University of Alberta a more reasonable and perhaps affordable one. Therefore, the measurements for the bars, as well as the size and colour of the tiles, were determined according to the availability of the US product, which acted as the main parameters for the design and layout of the guidance texture at the Alumni Walk (see Figure 22):

Standard size tiles of 12 x 12" were paired together, to create a surface 24" wide. The use of a wide surface is recommended by the UK DFT guidelines (1999). After analyzing the route during winter it was noted that snow was piled up at the edge of the pathway, covering part of it; a 12" wide texture might be affected by this factor and would be hard to follow.

The length proposed for the guidance texture was 26' long, which was to ensure students reach the pathway going north and to prevent them from taking the pathway going north-east.

The edges of the raised bars had a beveled finish, to allow a smooth movement when users are sliding the tip of the cane from side to side in order to scan the texture. This bevel replaced the rounded edges indicated by the ADA and the DFT guidelines.

Although the publications *Clearing our path* (CNIB, 1998) and *Barrier-free design* (CSA, 1995) did not provide specific guidelines regarding the use of colour for tactile surfaces, they recommended the use surfaces that contrast against the surrounding paving surface (CNIB; CSA).

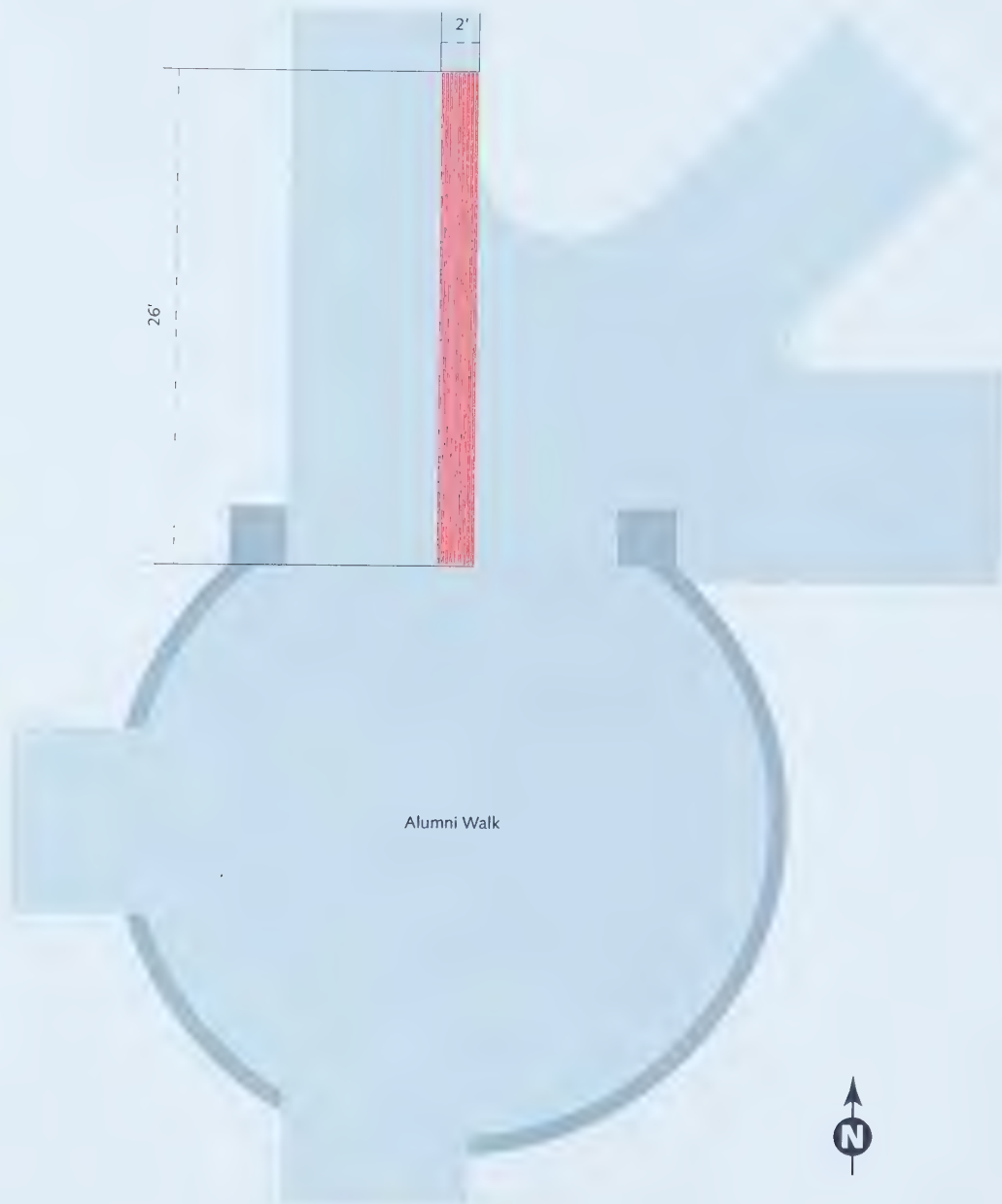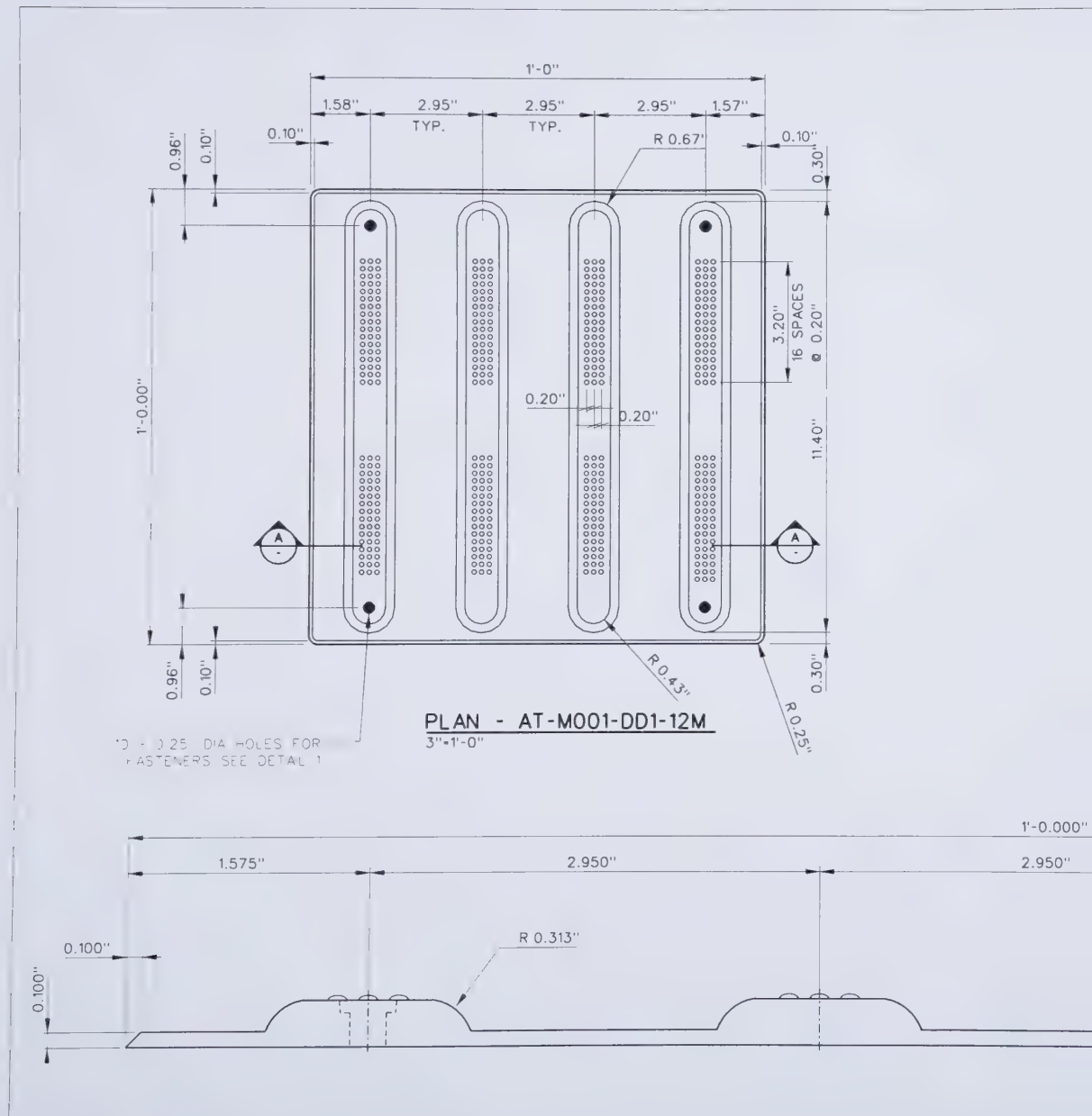**Figure 20.** Layout for the guidance texture, for the proposed orientation system

Figure 21 . Plan and section for guidance texture approved by the ADA,
available for purchase at the US

PLAN - AT-M001-DD1-12M
3"=1'-0"

Red colour was considered appropriate for the guidance texture because:

- it could provide good contrast against the concrete as well as snow
- it is a colour available for purchase at the US
- it would make the guidance texture distinguishable from the detectable warnings surfaces currently applied at staircases and platform edges of the LRT, which are coloured yellow

Four-way intersection texture

Whereas the guidance texture described above is meant to be followed, at a four-way intersection the user will have the option of turning left, right, or walking straight. These multiple courses of action need to be indicated to blind/partially sighted users.

According to the UK DFT (1999), upcoming turning points on a pathway could be indicated to blind/partially sighted pedestrians by a change on

Figure 22. Plan and section of guidance texture for the orientation system (scale 1:4)

1.34"   2.95"

0.3" (5 mm)

1"

24"
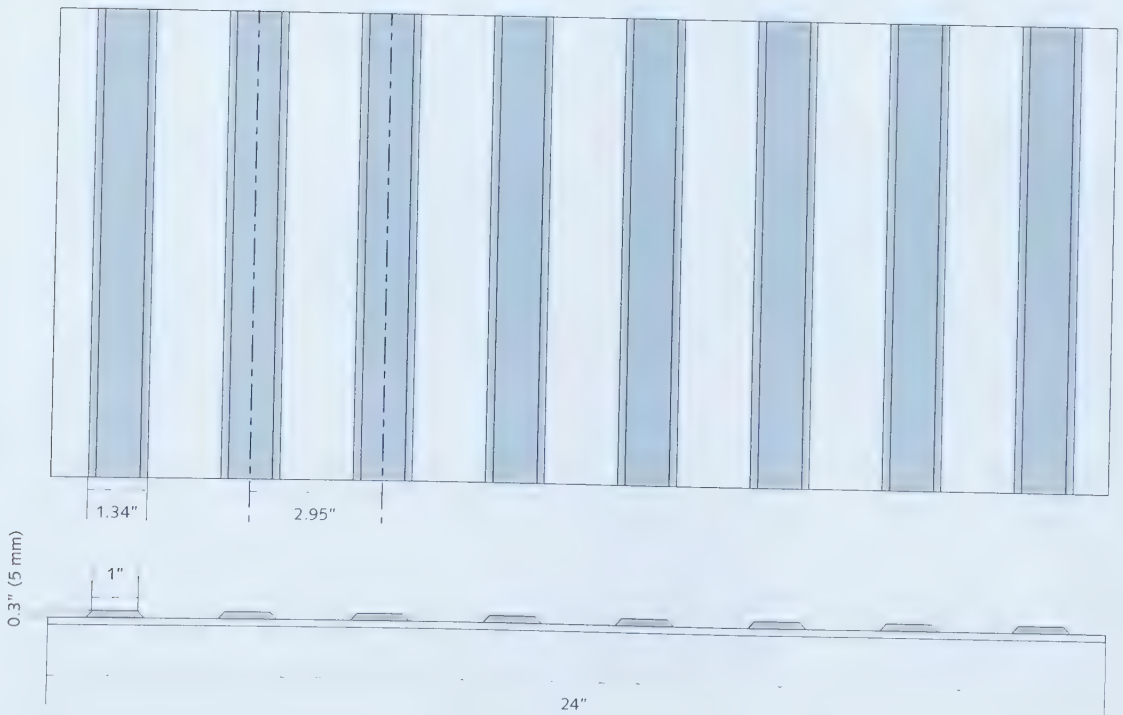
the tactile surface. The document Guidance on the use of tactile paving surfaces (UK DFT) explained, "Where a right angle turn in the guidance path is necessary, the surface should be installed so that the bars run transversely across the direction of pedestrian travel for 1200 mm (or as long as possible up to a maximum of 1200 mm) before the bend in both directions" (p. 66). This recommendation of indicating upcoming turning points, by rotating the raised bars from the guidance texture, was implemented for the proposed accessible orientation system. Same 12 x 12' tiles with the guidance texture profile would be used for the *four-way intersection texture*, placing the bars across the line of direction; starting 4' (1.219 mm) before the crossing point (see Figure 23). For the turning point, the bars were mitered (see Figure 24). Red colour was used as well, to keep the consistency of the system.

Figure 23. Layout for the four-way intersection texture and poles
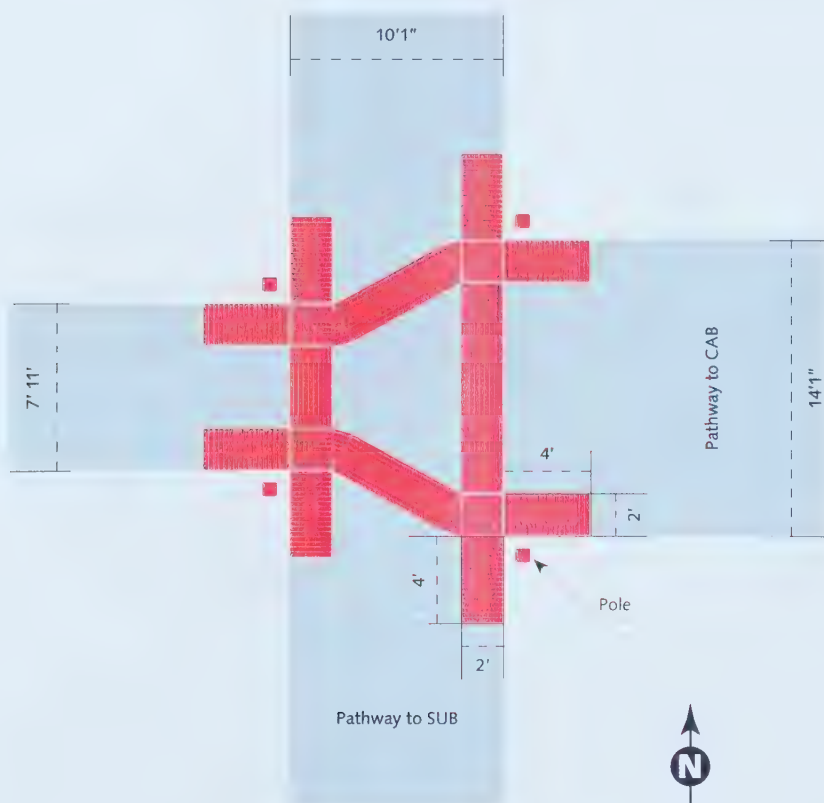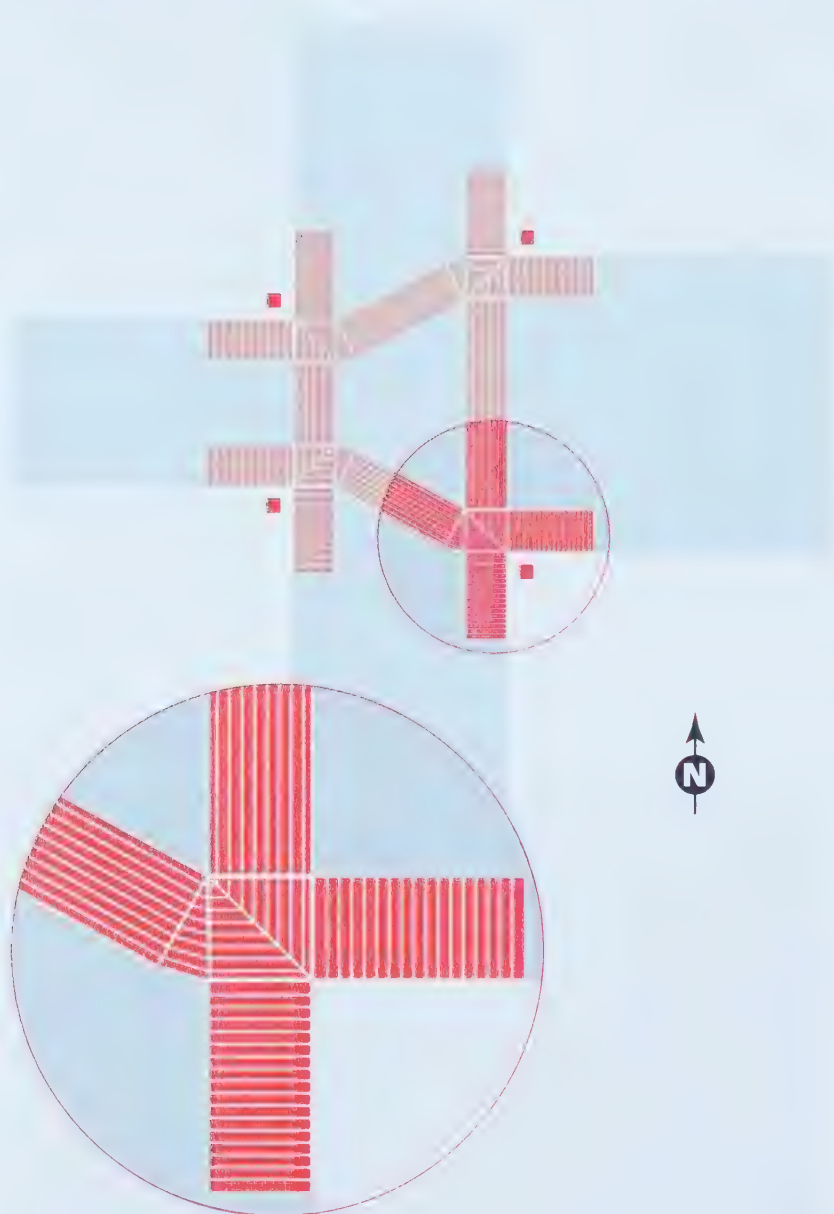
Figure 24. Detail of the four-way intersection texture, produced for the prototype testing

9. Janice Brandt, Orientation
    and Mobility Instructor for
    the CNIB, was consulted to
    acknowledge if this exposed
    aggregated surface had been
    reported as unpleasant by
    blind/partially sighted users.
    According to her experience,
    that has not been the case.
    (J. Brandt, personal commu-
    nication, March 15, 2006).

Information texture

The UK Department for Transport's guidelines for tactile paving surfaces (1999) stated that the *information surface* should not have a raised profile, yet it is detectable because it feels slightly softer underfoot than conventional paving materials. This surface should have a matt finish and be slip resistant, based on a neoprene rubber or similar compound (UK DFT).

Taking into account the effect of Edmonton's winter on outdoors surfaces—snow, ice, slippery pathways—and considering the aesthetic aspects of the system, surfaces other than the soft rubber were considered for testing. A texture of pebbles over concrete, known as *exposed aggregate finish*—commonly used for landscaping purposes—could work as a tactile surface to indicate the informational landmark (see Figure 25). In some cases, people who have low vision might dislike certain textures, surfaces or materials when perceiving them by touch (Jean Jackson, personal communication). However, no published information or studies regarding the users' reaction to different tactile paving surfaces were found while this thesis project was conducted.[9]

Figure 25. Sidewalk with exposed aggregated finish, Edmonton

Based on the opinion of consulted experts[10], the *information texture* should extend across the full width of the pathway to ensure that it is detected. Following the UK DFT recommendations (1999), the textured surface should be 800 mm wide, 400 mm from the center point determined by the informational landmark (see Figure 26).

Figure 26. Layout for information texture and placement of informational landmark
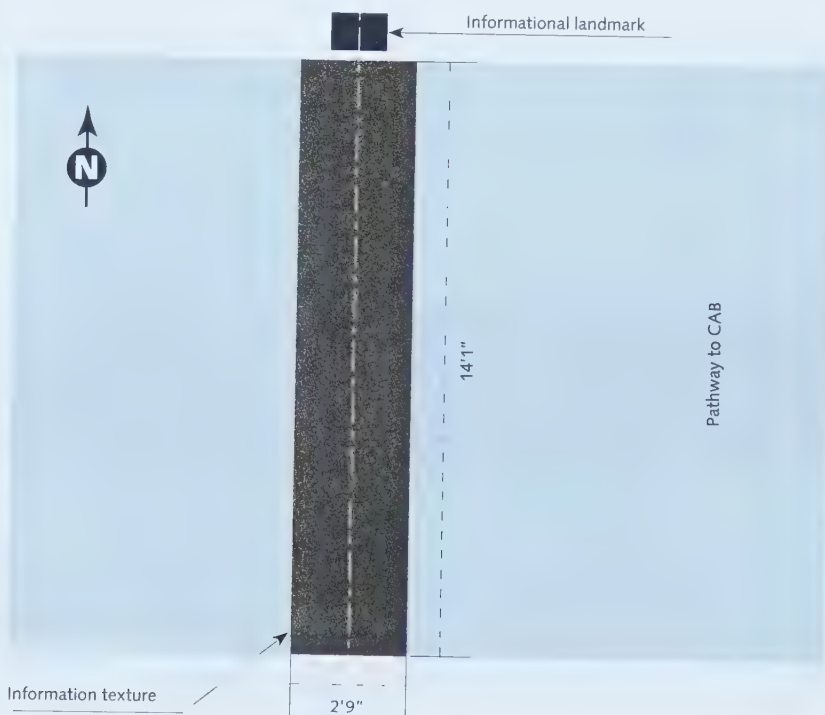
Fixed poles placed at turning points
Having a second orientation aid to indicate turning points would acquire special importance in winter, when the snow might cover the textured paving surface. By placing poles painted with saturated colours on each corner of the intersections, conspicuousness would be improved and the location of turning points would be highlighted; students would be able to detect the poles using their vision and/or cane.

11. According to the CNIB
document *Clearing our path*
(1998), cane detectability
should be at ground or floor
level. During the benchmark-
ing process it was noted that
the ground level for edges
of pathways was drastically
altered in winter, due to the
accumulation of snow.

For the poles to be placed at turning points, the following physical attri-
butes were determined, in order to provide conspicuousness and legibility:

1. Red was used for the poles because it would maintain the consistency of
   the system, since it was used for the guidance and the four-way intersec-
   tion textures. The decision of using red was also based on a comparison
   between three different colours—red, green and yellow—against two
   photographs of the landscape, taken during fall and winter seasons (see
   Figure 27). Red provided sufficient contrast against both backgrounds.

2. Poles should be at least 32" height (see Figure 28), to rise above the level
   of accumulated snow in winter.[11]

3. Poles should be square based, to emphasize the direction of the
   intersecting paths.

Figure 27. Colour exploration for four-way intersection poles, in fall and winter seasons

Fall season

Winter season

Informational landmark

Hill and Ponder (1976) explained the importance and use of landmarks
for the navigation of people who are blind/partially sighted (see Section
4.3, Orientation and mobility: navigation for people with low vision).
Presently, outdoor landmarks used on campus by students that are blind/
partially sighted, include trash cans, recycling bins and benches (J. Brandt,
personal communication, January 23, 2006). A fixed object, such as a

Figure 28. Elevation and plan for the poles placed at turning points

Elevation

Plan
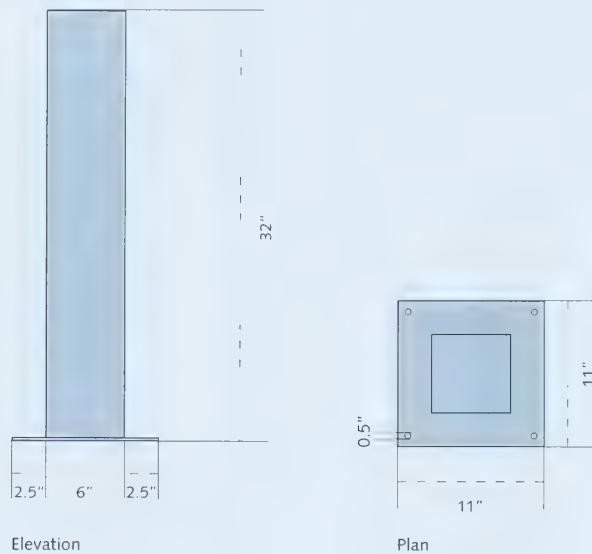
landmark that would be cane and visually detectable, could improve on-campus navigation for students with low vision. It was also observed that these landmarks, unlike trash cans and benches, could act as an information system as well, by attaching a visual/tactile sign to them.

The informational landmark, designed to be cane and visually detectable, consisted of a fixed black post where a visual/tactile sign was attached. The rectangular base of the post was intended to provide a flat surface, where students could align themselves for a straight line of travel, parallel or perpendicular to the landmark (Hill & Ponder, 1976).

Starting from the floor, the minimum height for the visual/tactile sign was 3'4", with a maximum height of 4'2" (see Figure 29). This height range was considered accessible for wheelchair users (CNIB, 1998; University of Alberta, n.d.) who would be able to see and/or touch the sign and would accommodate the needs of tall users as well. Considering that the minimum height was lower than the standard sight line recommended by the *Sign design guide* (Barker & Fraser, 2000), the visual/tactile sign was placed in a 30° angle slope, to increase visibility within the maximum eye rotation (Panero & Zelnik, 1979).

Figure 29. Elevations and plan for the informational landmark post

Front view

Side view

Plan

Visual/tactile sign for the informational landmark

A visual/tactile sign could be useful for fully sighted, partially sighted and blind people (Barker & Fraser, 2000; RNIB, 2002). The visual/tactile sign for the informational landmark aimed to provide information that might be useful for on-campus navigation. It was designed following recommendations provided by the JMU *Sign design guide*, the RNIB *See it right* pack, and the CNIB guidelines for tactile signs:

Format
A format of 11 x 11 1/2" was determined for the sign. This format is standard for tactile graphics such as thermoform and microcapsule paper.

Tactile features
Several publications about tactile signs (Barker & Fraser, 2000; CNIB, 1998; RNIB, 2002) explained that characters and symbols presented on informational signs should be raised at least 1.5 mm from the surface. These documents also explained that the edges of the characters should be beveled to prevent harming the users' fingers, but half-rounded characters were not recommended (Barker & Fraser). Based on these findings, tactile features for the informational landmark were raised 2 mm (about 1/16") above the sign surface.

Two Braille locators, raised 2 mm high on the left edge of the sign, indicated the location of tactile symbols as well as the Braille text.

Colour
All visual information was printed in white on a dark background, as recommended by several studies regarding legibility for partially sighted people (Arditi, 2003; CNIB, 2006a; RNIB, 2002).

A red coloured bar on top of the sign was proposed to enhance the landmark's conspicuousness.

Typeface
Studies addressing legibility for partially sighted people recommended using sans serif typefaces, such as Helvetica or Arial (Barker & Fraser, 2000; CNIB, 2006a). The questions raised from these recommendations were that new typefaces had become available after these studies were conducted, and that visual communication designers and type designers were not always consulted for these investigations.

Hence, there was a possibility that the suggested typefaces were not the most legible ones currently available.

To investigate how different sans serif typefaces would perform under low vision conditions, a blurring filter was applied to a pre-selection of fonts, including Helvetica, Lucida Grande, Myriad and Univers (see Figure 30).

Results of this investigation showed that Lucida Grande exhibited features which contributed to legibility (see Figure 31), including:

- large, open counters
- large x-height
- open apertures
- noticeable difference between ascenders and descenders
- appropriate thickness of the strokes, which helped with legibility over the dark background
- distinguishable shape of the characters; for example, the tail of the Lucida Grande lowercase 'a' made it distinguishable from the lowercase 'e'

All these characteristics were supported by the recommendations of experts such as the CNIB (1998, 2006a), the RNIB (2002) and Barker and Fraser (2000). Therefore, Lucida Grande was used for the text in large print format.

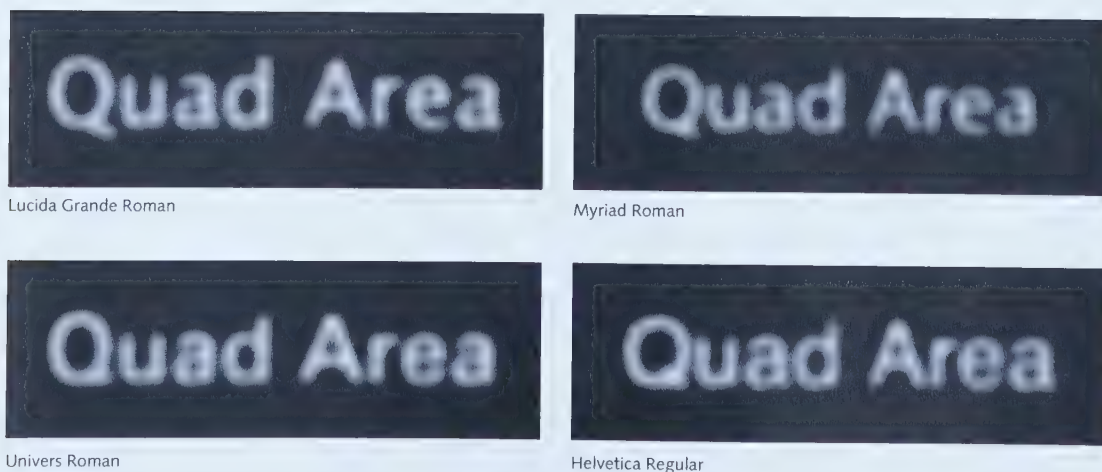**Figure 30.** Blurring filter applied to different typefaces, to check their performance

Lucida Grande Roman

Myriad Roman

Univers Roman

Helvetica Regular

Figure 31. Structure and features of Lucida Grande typeface, that contributed to legibility

Large x height

Large counters

Distinguishable ascenders

xabcdefg

Distinguishable shape of characters

Open apertures
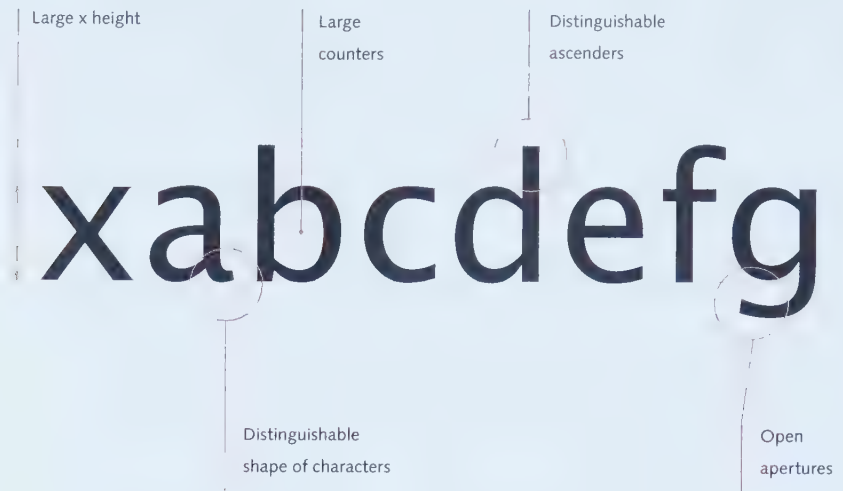
Layout of information presented on the visual/tactile landmark
Organization of the information, in a structured way, may facilitate the consistency of the system for future application (Barker & Fraser, 2000; Lidwell, Holden & Butler, 2003); that is why the sign surface was divided in three main sections according the data presented (See foldout, Figure 32). In order to be distinguishable by touch, the sections of the sign were separated using indents.

1. *Identification (top section)*

The findings of the student interviews showed that, at least four areas of the University of Alberta campus, presented several complex situations regarding wayfinding and navigation, and were particularly difficult to navigate (see Section 5.2, Student interviews). In order to provide a logical structure for the distribution of the landmarks, and to facilitate the area recognition by users who are navigating on campus, a number was assigned to each complex area. Starting at the north-east end of campus, the corresponding number for the Quad area was 3 (see Figure 15, map of the four complex areas for navigation).

The identification of the landmark consisted of the combination of the area number (i.e. '3', for the Quad area) and a letter, combination that will be unique for each landmark. This way, each area could present

up to 26 landmarks. The identification provides an element that will be unique for each landmark, to help with its recognition. In addition, by memorizing the landmarks they are supposed to encounter when navigating a specific route, users will have the opportunity to confirm if they are going in the right direction.

Type size for the identification number was 60 mm high as recommended by the JMU (Barker & Fraser, 2000), in order to be legible from a distance of one meter, and raised 2 mm (about 1/16") in order to be detectable by tactile means (Barker & Fraser; RNIB, 2002).

In addition to the identification number and letter, the name of the area where the landmark was located (i.e. Quad area), and the facing direction of the landmark, were indicated in large print format.

A saturated red colour was used for the background of section 1, to provide contrast against the landscape and distinguish the identification of the landmark from the rest of the information.

2. *Indication of campus major landmarks (middle section)*
Based on Hill and Ponder's (1976) observations about cardinal directions, and the findings of the student interviews, using a compass to show the location of the University major landmarks could be more helpful than using a tactile map of the surroundings (see Section 5.2, Student interviews).

A compass was designed to be detectable by visual and tactile means. The compass was 55 mm high, maintaining visual legibility from a distance of about one meter (Barker & Fraser, 2000; RNIB, 2002). This size also provided enough space surrounding the symbol, to improve tactile legibility. The compass was raised 2 mm (about 1/16") above the surface of the sign, in order to be perceptible by touch. A dot of 5 mm was placed at the center of the compass, to provide a cue of the users' location.

As dictated by conventional maps, north is always presented at the top of the compass. An arrowhead was used to distinguish north from the other directions. Braille and large print format text (24 point size) indicated the cardinal directions at the compass.

The fact that the visual/tactile compass would be always pointing north led to an interesting situation. If the informational landmark does not face north, the symbol's indication of the cardinal directions might mislead the users, making them believe that by following the arrow (walking straight ahead) they would reach north. Therefore, users should be facing north when reading the landmark; that way, by refering to the compass' arrowhead, they can determine their direction of travel. The consistent placement of the landmarks could improve the usability of the orientation system as well, because users will know that, every time they read a landmark, they will be facing north.

On the right side of section 2, a text in large print format (30/48 point size) was used to indicate which major landmarks were located in each direction. U of A campus' buildings that were familiar, prominent, and located in the vicinity of the informational landmark, were selected for each cardinal direction:

- Biological Sciences (known by students as 'Bio Sci') for north
- Central Academic Building (CAB) for east
- Student Union Building (SUB) for south
- Computing Science for west

3. *Braille text (bottom section)*
The lower section of the sign presented, in Braille, all the text of the first two sections as follows:

3.a Quad area
You are facing north
n: Bio Sci
e: CAB
s: SUB
w: Computing Science

Grade 2 Braille was used because the length of the text was more compact than by using grade 1 Braille. Several relevant publications explained that grade 2 Braille is accepted for visual/tactile signs for the same reason (Barker & Fraser, 2000; RNIB, 2002).

3.a Quad Area

You are facing north

N Bio Sci
E CAB
S SUB
W Computing Science

60 mm (2.36")

55 mm (2.16")

3.45"

4.6"

11.5"

3.45"

11"
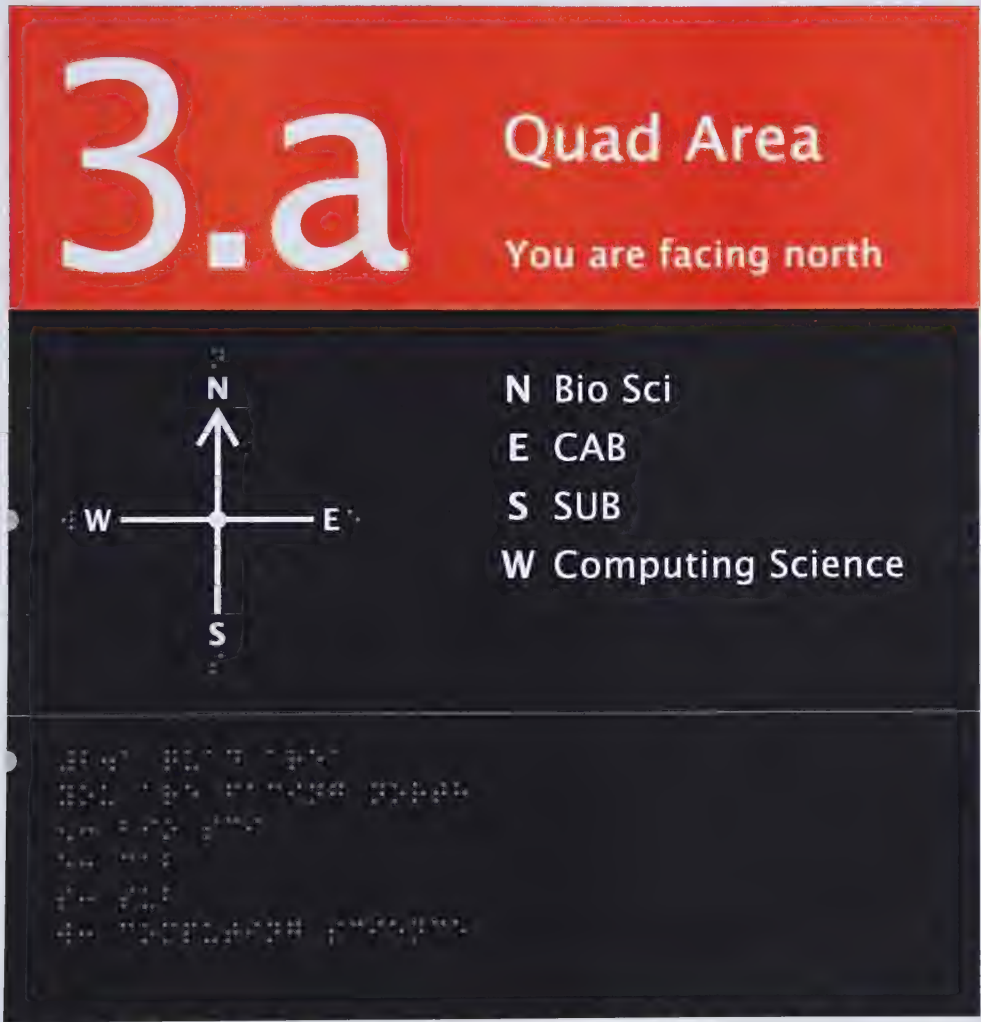
6.2 Production of the prototypes

A prototype of the proposed orientation system, to be applied on the se-
lected route, between SUB west entrance and CAB east entrance, was pro-
duced to test the performance of the system. Time and financial constraints
did not allow the production of the system using the actual, commercially
available materials; however, the intention of the study was to determine
how conspicuous, legible and useful the system would be, characteristics
that do not necessarily depend on the materials used.

Guidance texture

The measurements defined for the guidance texture surface were 2 x 26'.
Boards of red corrugated plastic (*Coroplast*) 4 mm thick were used for the
base of the texture. Pieces of 4 x 2' were cut from the original boards, in
order to create modules that could be joined by hinges. The idea of the 4'
long format for the modules was to facilitate the transportation of the tex-
ture to the Alumni Walk, taking into account the 26' length of the surface.

The raised bars, to be applied over the base, were created by cutting strips
1" wide. Stripes of cardboard 1 mm thick were pasted to the *Coroplast*
bars, to achieve the 0.3" (5 mm) recommended by the UK Department for
Transport. Although the guidance texture bars are composed by segments
of 11.4" long rather than continuous bars, the later was used due to time
and cost constraints for the production of the prototypes.

After pasting the strips to the *Coroplast* base, red *Duct Tape* 2" wide (48
mm) was applied on top of the strips. By gently compressing the edges of
the tape to the base of the texture, the beveled finish for the bars was cre-
ated. The bevel expanded the width of the bars from the original 1" to the
1 1/3" (35 mm), complying with the ADA and UK DFT requirements.

Four-way intersection texture

To make the prototype cost and time efficient, a tactile paving surface was
produced solely for the area of the four-way intersection included on the
route (see Figure 24, detail of the four-way intersection texture produced
for the prototype testing). Two portions of the guidance texture that
would follow the turning points' paving surface were produced as well,
because it would be important to observe if the change of texture would
affect the perception of the four-way intersection layout.

Red *Coroplast* boards were used for the base of the texture. Four pieces 4 x 2' were cut, in order to create the turning point texture and the guidance texture, to be placed after the turning point indication. A 2 x 2' piece was used for the tile with mitered bars.

Same as for the guidance texture, the 5 mm height bars were created using 1/32" (1 mm) thick cardboard, red *Coroplast* strips and red *Duct Tape* for the bevel. For the texture indicating the turning point, the bars were placed across the length of the board.

Poles for turning points

Four poles, one for each turning point at the four-way intersection, were built using a wooden base covered with red *Sintra*, a weatherproof PVC foam board commonly used for signage production. An 11 x 11" base with four holes allowed installation, fixing the poles to the ground with nails about 4" long.

Information texture

The measurement for the information texture surface was 4.150 mm (14.1' or the width of the sidewalk) by 920 mm—about 2'9" , minimum width required to be foot-detectable according to the CNIB (1998) and the UK DFT guidelines (1999). To facilitate the transportation of the prototype to the selected route, four pieces of vinyl flooring 41 x 33" were used as a base for the information texture. Construction adhesive was used to glue 3/8" gravel to the vinyl. A sealant was applied once the gravel was fixed to enhance durability.

Informational landmark

The informational landmark pole was built as a wooden structure covered with black *Sintra*. Several techniques were used to produce the sign attached to the pole:

1. Text in large print format was produced using silkscreen process. Because of the transparency of the inks used for silkscreen, white pigment on dark background would not produce a 100% white text. Therefore, the text was reversed, using red and black ink over white *Sintra* to ensure good contrast and sharpness for the type.

2. Braille texts were printed using a *Perkins Brailler*, a typewriter machine that prints Braille characters.

3. All raised parts of the sign (tactile identification number, compass and Braille locators) were created using white linoleum 2 mm thick (about 1/16").

7. DESIGN EVALUATION

In order to evaluate the level of accessibility of the proposed orientation system, the prototypes were tested. The collected data from the testing procedure was analyzed and discussed.

7.1 Prototype testing

This study involved testing a prototype of the proposed orientation system with University of Alberta students who are legally blind/partially sighted.

Objectives

The general objective for this study was to determine if the proposed orientation system was an answer for the original research question:

> *How can outdoor on-campus orientation and navigation be improved for University of Alberta students who are blind/partially sighted?*

In addition, in order to evaluate the performance of the system, two specific research questions were formulated:

> *Which features of the proposed orientation system, tested on the SUB to CAB route, at the University of Alberta Campus, would facilitate navigation for students who are blind/partially sighted?*

> *Is the proposed orientation system accessible for students who are blind/partially sighted?*

Specific objectives for the testing procedure included:
- to assess which features of the system addressed the needs of being conspicuous, legible and useful to the users.
- to determine if the system could help improve blind/partially sighted students' on-campus navigation
- to evaluate the effect of the system on the efficiency, safety and confidence of users/students for on-campus navigation

Test participants

After the study was approved by the Arts, Science and Law Research Ethics Board, at the University of Alberta (see Appendix A, Ethics application), an invitation was sent by e-mail (see Appendix D, Prototype testing materials) to the six students that were previously interviewed. Students were contacted through the University of Alberta SSDS.

Four University of Alberta students, who are legally blind, participated in the testing process. Of these students, Participants 1 and 2 were totally blind. Participant 3 had light perception, and Participant 4 had enough remaining sight as to read large text format. Participants 1, 2 and 3 used the white cane as a mobility aid. Participant 4 did not use any kind of mobility aid for this task.

Test materials

a. Prototype

A prototype of the system was produced and installed on the selected SUB to CAB route (see Figures 33–36). Due time constraints, and to make the testing procedure cost-effective, a partial representation of the four-way intersection texture was produced. See Sections 6.1 and 6.2 for relevant information regarding prototype design and production.

b. Questionnaire

A document was created with 19 Likert scale questions, 22 open-ended questions and one ranking question, which addressed the accessibility of the orientation system that was tested (see Appendix D, Prototype testing materials). Questionnaire was sent, via e-mail, to each participant after the test was completed. The questionnaire was organized into four sections, to address the issues presented by the research questions:

1. *Conspicuousness*

Participants were asked to determine, using a five-point scale going from 'very easy' to 'very hard', the level of difficulty for detecting each one of the system's features.

2. *Legibility*

Participants were asked to determine, using a five point scale going from 'very easy' to 'very hard', the level of difficulty for reading and understanding each one of the system's features.

3. *Usefulness of the information*

Participants were asked to determine, using a five point scale going from 'much easier' to 'much harder', if the system and its features improved or made worse the navigation process for the selected route.

4. *Personal feedback*

Participants were asked to make comments about the proposed orientation system.

Test procedure

Participants were asked to walk the same route from the benchmarking phase: from Student's Union Building (SUB) east entrance to Central Administrative Building (CAB) west entrance (see Figure 17, selection of route). The original procedure consisted of reading a set of instructions to each participant including a general description of the orientation system they were going to face (see Appendix D, Prototype testing materials). Students were asked to walk on their own, to the best of their ability, using the orientation system as a resource for navigation. In order to observe the performance of the system as well as for safety reasons, the role of the researcher was to accompany the students, although without intervening in the task. Participants were allowed to ask questions, and withdraw from the task at any time.

After Participant 1 used the system, it was noted that the level of interaction between the student and the system was not as complete as expected. The participant's natural reaction to unfamiliar paving surfaces was to avoid them, an unexpected outcome that affected the interaction with those features depending on the surface's texture to be detected, such as the *informational landmark*. After consulting with Jean Jackson, Advisor and Alternate Format Coordinator at the University of Alberta, it was suggested that the researcher should follow the mobility training process established by the CNIB, which consists of guiding the user through unknown paths or routes, facilitating the interaction with the environment and introducing the user to all cues and landmarks they will encounter. The participant agreed to walk the route again while being guided by the researcher, through the paved surfaces and landmarks provided by the orientation system. The participant was willing to walk the route a third time, on her own, after the training process.

The procedure of walking the route three times was adopted for all the participants, since it complied with the training process followed by orientation and mobility experts. Participants' interaction with the system,

under familiar and unfamiliar conditions, provided information about how the system would work for the user in two different scenarios:

1. First time users with no training for using the system.

2. Users who had experienced navigation using the system.

After the testing, participants were asked to answer the questionnaire at home and to send their responses, via e-mail, to the researcher as it would be easier for the students to use their own assistive technologies (i.e. screen readers, magnifier glass) to access the questionnaires in order to answer them.

Data collection
During the prototype testing process, quantitative and qualitative data was collected to obtain information about the system's conspicuousness, legibility and usefulness. The data was collected using two different methods:

1. Video and voice recording.

2. Post-testing questionnaires.

Analysis of collected data
The analysis of the information obtained aimed to address some of the accessibility issues discovered during the problem detection stage and the first two phases of this research project. The quantitative data collected helped to evaluate how conspicuous, legible and useful was the system for participants. The qualitative data helped to identify the design aspects that established the level of conspicuousness, legibility and usefulness.

Questionnaire responses were examined to determine:
• the level of conspicuousness of features of the system
• the level of legibility of the features of the system
• the level of usefulness of the system
• the overall navigation experience, and if it was positive or negative

To obtain an observation of the navigation process and the participants' interaction with the orientation system, video and audio recordings were reviewed and compared with the participants' responses to the questionnaires.

Figure 33. Guidance texture at the Alumni Walk exit

Figure 34. Prototype of four-way intersection texture and poles

Figure 35. Layout and detail of information texture

Figure 36. Prototype of informational landmark

Results of the scaling questions were represented as bar graphs, to provide a visual overview of the quantitative data collected, facilitating the analysis of the information. Green was used to highlight positive responses to the system's features; red was used to highlight negative responses, and gray for neutral responses (see Appendix E, Results of prototype testing). In addition, the evaluation for each feature was presented as a table, in order to summarize the results and reveal patterns among participants' responses.

The analysis of the data collected during the prototype testing phase, also helped to determine the user's preferences, unexpected outcomes, and design recommendations for future development of the orientation system.

7.2 Discussion of testing results

A discussion of the results was organized according the structure of the system: *guidance texture, four-way intersection poles, four-way intersection poles, information texture, informational landmark,* plus general observations. The first three sections of the questionnaire, which concerned conspicuousness, legibility and usefulness of the system, were maintained for the structure of the discussion to relate testing results to the issues presented by the research question, and to determine the performance and functionality of the prototype as an accessible orientation system. The data obtained from fourth section of the questionnaire, entitled *personal feedback*, was merged with the information obtained through the first three sections of the questionnaire, adding the comments where pertinent. The annotations of this section were brief, but indicated whether the navigation experience was positive or negative for the participants, and pointed out specific features of the system that proved to be especially helpful to them.

Evaluation of the guidance texture

a. *Conspicuousness*

Participants 1 and 2 replied that finding the guidance texture at the beginning of the route was 'very easy'; Participants 3 and 4 responded that it was 'easy'.

Participants reported that the edge of the texture and the texture itself were easy to detect using the cane. They also explained that the surface of the pathway and the *guidance texture* were drastically different, which

was considered a positive attribute. Participant 4 stated that the bright red made the texture conspicuous; however, she was concerned that the texture may be too narrow and students who are totally blind might miss it.

All participants who had a white cane as a mobility aid, reported that they used it to find the *guidance texture*. Three out of four participants used their feet to detect the texture. Only Participant 4 reported that she used her sight as well as her feet to find the texture.

b. *Legibility*

Participants 1, 2 and 3 replied that following the *guidance texture* at the Alumni Walk area was 'very easy'. Participant 4 reported that it was 'easy'. They commented that the direction of the bars was clearly perceptible by tactile means. In addition, students who used a white cane as a mobility aid reported that the raised bars allowed them to put the tip of the cane between them to slide it along the texture, without slipping to the sides.

Participants 1, 2 and 3 reported they used their canes as a main aid to follow the *guidance texture*. All participants used their feet to follow the texture as well.

c. *Usefulness of information*

Participants 1, 2 and 3 replied that, in comparison with not having the system, the *guidance texture* at the beginning of the route made the task of finding the pathway 'much easier'. Participant 4 thought the task was 'easier'.

All participants thought that having a *guidance texture* would be a good solution for navigating complicated areas with paths going in different directions.

Participant 1 reported that the texture showed him exactly where to go, in an area where he was usually guessing. Participant 2 stated that the *guidance texture* helped him to know that he was on the particular path he wanted and not on any other. Participant 3 observed that the *guidance texture* allowed her to keep a straight line of direction. Participant 4 pointed out that, although it was easier for her to find the correct path,

it is very likely that the marker will not be as obvious if the light condi-
tions change (i.e. at dusk) because she requires good lighting to be able
to use her residual sight.

Figure 37. Summary of evaluation of guidance texture

Positive outcome

Neutral outcome

Negative outcome

P   Participant

Conspicuousness	Legibility	Usefulness
P1 P2 P3 P4	P1 P2 P3 P4	P1 P2 P3 P4

Use of the four-way intersection texture

a. *Conspicuousness*

Participants 1 and 2 reported that finding the textured surface installed
at the four-way intersection was 'very easy'; Participants 3 and 4 re-
sponded that it was 'easy'.

As with the *guidance texture*, all participants who had a cane reported that
they used it to find the *guidance texture*. Three out of four participants
used their feet to detect the texture. Only Participant 4 reported that
she used her sight, as well as her feet, to find the texture.

b. *Legibility*

Participant 2 found that following the *four-way intersection texture* was
'very easy'; Participants 1 and 3 thought it was 'easy' to follow. Only
Participant 4 thought that following the texture at the four-way inter-
section was 'not easy nor hard'.

All participants agreed that having raised bars across the line of
direction was an intuitive and clear way to indicate a turning point is
forthcoming. It was pointed out that the surface with the mitered bars
was small and, therefore, hard to detect. During the videotape analysis it
was noted that students perceived where to turn by simply detecting the
change of direction of raised bars. Participants who missed the turning
point kept walking straight, realizing they had reached a surface with

a *guidance texture*. Consequently, they retraced their steps searching for the texture with the bars across; once the right texture was found, they turned and continued walking on the right direction. This outcome confirmed participants' responses and suggested the mitered bars area was not necessary to indicate a turning point. All participants used their feet to detect the direction of the four-way intersection's texture. Participants 1, 2 and 3 used their canes as well.

c. *Usefulness of information*

Participant 2 reported it was 'much easier' to turn using the texture, because it provided a better and more reliable warning than following the grass line. Participants 1 and 4 reported that it was 'easier'. Participant 3 responded that it was 'not easier nor harder', because there were other indicators in the path (i.e. the slope) that signaled the approach of the intersection.

Figure 38. Summary of evaluation of four-way intersection texture

Positive outcome

Neutral outcome

Negative outcome

P   Participant

Use of four-way intersection poles

a. *Conspicuousness*

Participants 1, 2 and 4 observed that the *four-way intersection poles* were either 'easy' or 'very easy' to find. Participant 3 replied that finding the poles was 'hard'. Participant 3 explained that there was little contrast between the red of the pole and the green of the grass, and that she was not able to visually detect the poles with her residual sight. In addition, the intersection texture was placed close to the edge of the sidewalk, a factor that interfered with her ability to trail the shoreline, making harder the detection of the pole using the cane. Participant 3 also noted that she had no previous experience using a *guidance texture*. She clarified

she was able to find the pole after its general location had been pointed out to her, during the training stage of the testing.

Students used their canes to find the *four-way intersection poles.* Participant 4, who did not have a cane, used her residual sight.

b. *Legibility*

Only Participant 2 agreed that the pole helped to identify the turning point. However, when analyzing the videotapes, it was noted that Participant 4 was able to detect the four-way intersection from an approximate distance of 48 . The conspicuousness of the intersection was attributed to the saturated colour of the poles.

It should be noted that the University of Alberta's outdoor environment changes drastically during winter. During the benchmarking process conducted in mid winter, students were not able to find certain landmarks such as the light pole placed at the corner of the intersection, due to the height of the snow piled up at the edge of the path. The poles could be a useful solution to indicate turning points, acting as reinforcement in case the texture at the four-way intersection becomes covered with snow during the winter months.

c. *Usefulness of information*

Only Participant 2 said that the *four-way intersection poles* made the task of finding the turning point much easier, as he found it with no difficulties using his cane. The rest of the participants reported that the pole did not contribute to find the turning point. Some reasons given include that they did not notice them until they were pointed out during the training process; and that the *guidance texture* led them to the intersection.

Figure 39. Summary of evaluation of four-way intersection poles

- Positive outcome
- Neutral outcome
- Negative outcome

P   Participant

Conspicuousness   Legibility   Usefulness

P1 P2 P3 P4   P1 P2 P3 P4   P1 P2 P3 P4

Use of the information texture

a. *Conspicuousness*

All participants reported that finding the *information texture* was 'very easy'. Participants 2, 3 and 4 used their feet to detect the texture. Participant 3 and 4 used their sight to detect the *information texture*. Participants 1, 2 and 3 reported they used their canes as well.
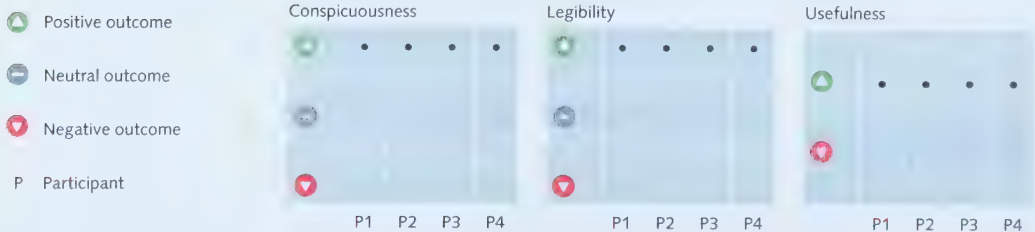
b. *Legibility*

All participants reported that distinguishing the *information texture* from the surface of the pathway was 'very easy'. Participant 1 solely used his cane to distinguish the texture. Participant 4 used just her feet. Participants 2 and 3 used both their canes and feet; the latter reported using her sight as well.

c. *Usefulness of information*

All participants responded that the *information texture* helped them to find the *informational landmark*.

Figure 40. Summary of evaluation of information texture

Positive outcome

Neutral outcome

Negative outcome

P Participant

Conspicuousness

Legibility

Usefulness

P1 P2 P3 P4

P1 P2 P3 P4

P1 P2 P3 P4

Use of the informational landmark

a. *Conspicuousness*

All participants reported that finding the *informational landmark* was 'very easy'. Participants 1 and 2 used their canes to detect the landmark. Participants 3 and 4 used their sight to detect the *informational landmark*. Participant 3, who has light perception, specified that she was able to detect the landmark visually, although without any degree of detail.

She described the landmark as "(...) a dark object with some lighter colouring on or near the top of it." This could be considered a successful description of the landmark's main features, taking into account that, for some students, the recognition of the landmark would rely on its visual and tactile conspicuousness. Participant 4 reported using her feet as well as her sight to find the landmark.

b. *Legibility*

During the videotape analysis, it was evident that all participants used the *informational landmark* without any difficulties even before the training process. All participants read the compass correctly and understood immediately that, since they were facing north, the way to get to CAB was to turn right and walk in that direction.

When asked what features of the *informational landmark* helped them to perceive the information presented on it, participants who were totally blind mentioned the Braille text and the tactile marks. Two out of four participants pointed out the compass and the text indicating which buildings were in which directions. Participant 1 mentioned the phrase 'You are facing north' was useful, Participant 2 mentioned the identification number '3.a'.

Identification number

Participants 1 and 3 found that reading identification number '3.a' by tactile means was 'very easy'. Participant 4 replied that distinguishing the identification number '3.a' by visual means was 'very easy'; it was observed that Participant 4 read the identification number in a comfortable posture and from a distance of about 2 feet. Participants who were totally blind replied 'not applicable.'

Compass

All participants replied that it was 'very easy' to understand the directional symbol (compass) when using tactile means to perceive it. Students attributed the clarity of the symbol to the fact that the direction they were facing (north) was indicated by the arrow, whereas a straight line represented the other directions. They also pointed out that the symbol had a good size and was raised above the surface enough to be detectable. Participant 4 replied that understanding the

directional symbol by visual means was 'very easy', mentioning that it had enough space around and had good contrast against the background.

Braille text
Totally blind Participants—1, 2 and 3—reported that reading the Braille text was 'very easy'. Participant 3 observed that the 'w' signaling the west at the compass symbol was slightly compressed, which made it rather difficult to read. This was attributed to the fact that the prototypes were built using light materials, a situation that would not occur when using real materials. Participant 4 did not read Braille.

Text in large print format
For the question regarding the ease of reading the text in large print format, Participant 4 replied that it was 'very easy' to read text, which was confirmed when analyzing the videotape. It was evident on the tape that Participant 4 read the text in a comfortable position and from a distance of about 2 feet.
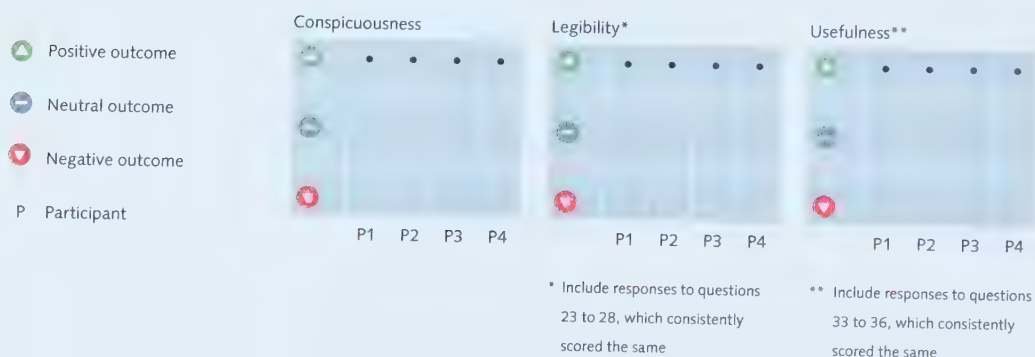
c. *Usefulness of information*
All participants confirmed that, in comparison with not having the system—the information presented on the *informational landmark* made the navigation at the Quad 'much easier'. When asked for reasons, Participants 1, 2 and 3 explained that the sign provided information about where other University of Alberta major landmarks were in relation to their current position. Participant 1 explained that usually he would need to walk and explore the area, visiting all the landmarks or buildings nearby, in order to confirm his position. Participant 4 commented that the *informational landmark* was easy to read and understand; and that it allowed her to confirm if she was going the right way.

All participants confirmed that the *informational landmark* helped them to find their way to CAB. All participants stated that the identification of the [Quad] area and the facing direction ('You are facing north') were useful pieces of information to have. One participant reported the landmark identification number ('3.a') was useful to her as well. All participants affirmed that the compass helped them to picture where

were they standing in relation with the U of A campus, and agreed that it was the most useful feature of the *informational landmark*.

After analyzing the students' comments, it seemed evident that providing a general layout of the Quad area, as opposed to a detailed tactile map of the vicinity, was useful. Participants were able to perceive the location of the major landmarks and the spatial organization of these landmarks, without having to process any extra information such as alternative paths, landscaping features, etc.

Figure 41. Summary of evaluation of informational landmark

○ Positive outcome

◐ Neutral outcome

▽ Negative outcome

P Participant

Conspicuousness

Legibility*

Usefulness**

P1 P2 P3 P4

P1 P2 P3 P4

P1 P2 P3 P4

* Include responses to questions 23 to 28, which consistently scored the same

** Include responses to questions 33 to 36, which consistently scored the same

General observations regarding the proposed orientation system

a. Conspicuousness

The results of the testing, users comments and analysis of the videos suggested that the system was sufficiently conspicuous for students who are blind/partially sighted. When comparing the participant's interaction with the orientation system through the three steps of the testing, it seems clear that the training process played an important role in the detection of the features of the system. Participants who did not find certain features the first time they walked the route, such as the *four-way intersection poles* and the *information texture*, where able to do so after the guided walk.

Students were given the opportunity to provide any suggestions about how to improve the conspicuousness of the system. All the participants

involved in the testing replied that the system was conspicuous enough. This response was supported by the analysis of the videotapes, which showed that in general participants did not have problems to find the features of the system.

Features that had dark colours, such as the *informational landmark* and the *information texture*, were reported as 'very easy' to detect by all participants. The red features helped participants who were not totally blind to find them. However, the red did not provide enough contrast within the environment for participants who only had light perception.

Textures that clearly differed from the paved surface of the pathway also helped to make the system conspicuous for all participants. Participants reported that it was either 'easy' or 'very easy' for them to find the *guidance texture*, the *four-way intersection texture* and the *information texture* because they were easy to distinguish from the pathway. The conspicuousness of the landmark may be correlated to the conspicuousness of the *information texture*, explaining why finding the *informational landmark* was 'very easy' for all participants, regardless the level of sight.

b. Legibility

Participants' responses and analysis of the data collected indicated that, in general, the orientation system was considered legible for students who are blind/partially sighted.

In general, participants found the paved textures easy to follow, although small areas were difficult for them to detect by using their feet, a factor that led to confusion in the turning point at the four-way intersection.

Braille and large text format worked as expected. However, some Braille letters were slightly compressed, an issue that was attributed to the materials used to build the prototypes. This fact was reported by one participant. Participant 4, who was able to read text in large print format, had a positive reaction to the use of white text over red and black background, indicating that this feature was helpful and improved the text legibility. There were no comments regarding the typeface used.

Participants also pointed out the identification number '3.a' as a positive feature. They have learned the shapes of conventional letters and numbers, and were able to recognize them without difficulty due to the size and depth of embossing of the forms.

When asked how the legibility of the system could be improved, participants answered that the legibility was very good. Two participants provided some ideas:

1. For the *information texture*, using a directional surface pointing towards the landmark instead of having a rough texture.

2. For the *informational landmark*, using Jumbo Braille (a larger version of the Braille characters) in order to help students who are not familiar with this tactile communication system, to read the Braille text.

New studies should be conducted to test the performance of the system, if these suggestions are finally implemented.

c. *Usefulness of information*

Participants' comments, as well as the analysis of the questionnaires and videotapes, suggested that the system was useful for students who are blind/partially sighted. The simplicity of the *informational landmark* was evaluated as a positive feature when interpreting the information presented there. Likewise the compass, signaling the directions and location of the major landmarks, seemed to provide valuable information that was not available for the students before.

Participants 1, 2 and 3 affirmed that, in comparison with not having the system, the general information provided by the orientation system tested made navigation 'much easier'. Participant 4 stated that the orientation system made the navigation 'easier'. Some participants reported that the system made them more confident that they were going the right way, especially in areas where they had previously bad navigation experiences. Participant 1 also explained that the components of the system were clearly laid out, easy to locate and provided the information he wanted.

Participants were asked to rank the five features of the system (*guidance texture, four-way intersection texture, four-way intersection poles, information texture* and *informational landmark*) in order of usefulness, 1 for most useful and 5 for least useful:

- the *guidance texture* was selected as the most useful feature for three participants and the as the third one for one of them, with an average rank of 1.5
- the *informational landmark* was the first choice for one participant and the second for three of them, with an average rank of 1.75
- the *information texture* was considered as the most useful feature by Participant D, second most useful by Participant C, third most useful by Participant A, and the least useful by participant B, with an average rank of 2.75
- the *four-way intersection texture* was the third choice for Participant B, and the fourth choice for Participants A, C and D, with an average rank of 3.75
- the *four-way intersection poles* were assessed as the least useful feature, evaluated as the fourth choice by one participant and the fifth for three of them, with an average rank of 4.75

Figure 40. Ranking of the five features of the system

1.50 guidance texture
1.75 informational landmark
2.75 informational texture
3.75 four–way intersection texture
4.75 four-way intersection poles
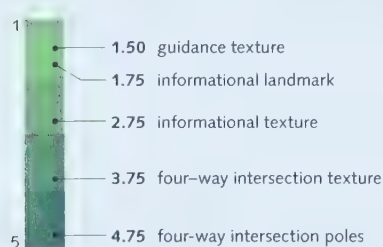
Participants commented that the system would reduce the need to stop and ask for directions, saving navigation time. They also affirmed that the different tactile paved surfaces and the *informational landmark* would be particularly useful for finding their way through unfamiliar routes, relieving some of the stress caused by the idea they might get lost when navigating on their own. However, participants pointed out that refine-

ments for the *guidance texture*, the *four-way intersection texture* and *poles* would be needed, as well as training for the users. They also stated the system could make them feel more confident when traveling on their own. However, this does not mean that it would make them feel safer. This point could be attributed to the fact that safety was not an issue with which they were concerned when navigating on campus. This was evident from the analysis of the student interviews conducted in January (see Section 5.2, Student interviews).

All participants thought that by implementing the system at the University of Alberta, the process of navigating on campus could be substantially improved for them. It is important to note that they also stated they would walk that path on their own if the system were applied. They attributed this statement to the increased self-confidence the system would provide.

Figure 41. Summary of general evaluation of the orientation system

Positive outcome

Neutral outcome

Negative outcome

P   Participant

Conspicuousness   Legibility   Usefulness

P1   P2   P3   P4   P1   P2   P3   P4   P1   P2   P3   P4

7.3 User preferences

The results of the testing showed that, in general, participants' responses to the system were positive. The following findings summarize which aspects of the system contributed to making it accessible, legible and easy to use for all participants:

1. Foot-detectable paved surfaces were considered helpful resources to make the system conspicuous and accessible for all users. These surfaces allowed totally blind students to detect and use them without the need of the white cane. Participants who were partially sighted mentioned these surfaces would be especially helpful under decreasing light con-

ditions, because they were able to follow them even when they could not see them.

2. Having large areas for the tactile paved surfaces was preferred by all participants. Smaller textured areas, such as the mitered bars at the four-way intersection's turning point, were harder to distinguish.

3. Crossing bars to indicate turning points were considered clear and easy to understand. This solution was preferred over having mitered bars at turning points.

4. Dark colours and tones, such as black and dark grey, stood out from the landscape and played an important role regarding the conspicuousness of the system. The black *informational landmark* and the dark gravel of the *information texture* were reported as 'very easy' to detect by all participants.

5. Participants able to read large text format commented that using white text over black and red background—as presented at the *informational landmark*—made it more legible and readable. The tone of the red bar on top of the *informational landmark* provided sufficient contrast for the white text.

6. The visual/tactile compass presented in the *informational landmark* was considered the most useful feature overall. Having directions to the location of major landmarks allowed participants to perceive the spatial organization of the surrounding area, which was considered helpful. Taking into account that most participants reported that they found tactile maps quite complex for navigation (see Section 5.2, Student interviews), this approach could be a useful alternate possibility.

7.4 Unexpected outcomes

Certain issues, which were not contemplated during the design process, emerged throughout the testing of the prototype and affected the participants' navigation experience. The results of the first step of the testing process, using the system for the first time and without guidance, suggested that intuitive navigation is not always possible for people who are blind/partially sighted. Two issues were noted:

1. Detecting physical landmarks located on the pathway's periphery, that is, landmarks that do not interfere with their navigation, requires specific training and guidance. Users need to know exactly where those landmarks are located, what are they going to find, what the landmarks' specific features are, and how the landmark would feel when perceiving it by tactile or visual means, or by using a mobility aid.

   For example, the pole placed at the turning point was not detected as intuitively as was expected. Totally blind participants detected the pole only when its location was pointed out to them. They had to consciously search for it using their canes or their hands. Participant 4 was able to detect the pole using her sight, but missed it the first time she walked the route. The participant explained that she had forgotten about the pole and was not focusing on finding it.

   Users did not notice the *four-way intersection poles,* until they were told about them during the training process. Three out of four participants declared the pole did not contribute to find the turning point. Participants also reported that the *guidance texture* led them to the intersection anyway, therefore, the poles were not necessary.

2. In general, users who are not familiar with sensorial experiences provided by the environment might react adversely and decide to avoid contact. In the case of the orientation system, some participants detected the different paved surfaces provided, but decided not to walk over them because they were told, by mobility and orientation experts, they should avoid any unfamiliar surfaces for safety reasons.

During the design stage of the orientation system, and after analyzing the selected route, it was considered that a saturated red would be a good choice for the paved surfaces and poles, because it would provide good contrast against the predominant seasonal colours occurring in outdoor environments: white during winter, green during summer and spring, and brown during fall and early spring. In fact, the saturated red helped participants who were partially sighted to find the correspondent features. However, it did not provide enough contrast for participants who only had light perception.

7.5 Design recommendations for development of the system

According to the results of the questionnaires and the analysis of the data collected from the testing process, the following recommendations should be considered for further development of the system:

1. The width of the *guidance texture* should be reevaluated. Further studies should be conducted to determine whether the proposed surface was too narrow, especially under winter weather conditions.

2. The tonal difference between the pathway and the paved surfaces colored red (*guidance* and *four-way intersection texture*) should be increased. Testing results suggested that a darker shade of red might increase the contrast between them. Likewise, contrast between the *four-way intersection poles* and landscape should be improved. A darker shade of red might help to increase tonal difference between the pole and the grass, although further testing is recommended.

3. For the *information texture*, the use of a directional surface pointing towards the landmark instead of having a rough texture should be considered. Further testing should be conducted to evaluate the functionality of such a texture.

4. For the *informational landmark*, using Jumbo Braille instead of regular Braille format should be considered; however, it would be important to assess the effect of the Jumbo Braille over the information layout.

5. A training program, to show users how to use the system, should be adopted if the system were implemented. Collaborative work with specialized departments and/or institutions—such as SSDS, CNIB—would be highly recommended.

8. IMPLICATIONS FOR FURTHER RESEARCH

The results of this study helped to determine which features of the proposed orientation system facilitated navigation for U of A students who are blind/partially sighted. The analysis of the data suggested that the system was useful for the participants, who demonstrated their interest in the future implementation of the system. This thesis project should be considered as a first approach to an accessible orientation system. In order to achieve successful implementation of the system, it is necessary to conduct further studies, summarized as follows:

Improve efficiency of turning points indicators

The data obtained from the prototype testing suggested that the poles, placed at the turning points of the four-way intersection, did not fulfill the goal of being easily detectable by cane or sight. Further research should be conducted to establish a more efficient way to indicate turning points. In addition, elements used as indicators for turning points have the potential to make each intersection distinctive, a factor that could be explored. As an example, by using sculptures instead of standard square-based poles, turning points would be indicated, while making each intersection distinguishable from another as well as aesthetically pleasing.

Determine colours suitable for tactile paving surfaces

The results of the prototype testing showed that, for participants who could only perceive light, the red colour used did not provide enough contrast against the concrete of the pathway. Published information concerning the use of tactile paving surfaces (CNIB, 1998; CSA, 1995; US Access Board, 2002), was limited to recommending colours that would contrast against the surrounding surface. The UK DFT document *Guidance on the use of tactile paving surfaces* (1999) addressed the specific use of red and yellow colour for the blister surface at pedestrian crossing points, yet did not provide colour guidelines for the six remaining textures. Research should be undertaken to establish a set of colours for tactile paving surfaces, suitable for users with low vision.

Determine colours for other features of the system

Further studies would be necessary to determine a suitable set of colours for other features of the system, such as the poles and the bar on top

of the visual/tactile sign, in order to provide enough contrast against the landscape. Testing the prototype with colour-blind users could determine if the colours currently used for the system would be distinguishable enough for them.

Use of a texture indicating the direction towards the informational landmark

After the prototype testing, one participant suggested that a directional surface, consisting of a series of V-shapes pointing towards the sign, could be used in order to indicate the location of the informational landmark. At the time this research was conducted, none of the documents regarding the use of tactile paving surfaces (CNIB, 1998; CSA, 1995; UK DFT, 1999; US Access Board, 2002) mentioned the existence of a similar texture. The concept of a directional surface presents interesting possibilities for exploration, and further research would be needed to establish an appropriate texture, that would be perceivable by cane and underfoot.

Use of serif or sans serif typefaces for the tactile/visual sign

Most studies regarding legibility for people with low vision stated that sans serif typefaces are easier to read (Arditi, 2003; Barker & Fraser, 2002; CNIB, 2006a; Hartley, 1994; RNIB, 2002). The choice of typeface for the visual/tactile sign followed the guidelines provided by these studies, showing positive results with participants who had residual sight. A previous study suggested that only people who are congenitally blind/partially sighted find sans serif typefaces easier to read, whereas people who became blind/partially sighted over time prefer serifed typefaces (Prince, 1967). This posed a question that could be answered by conducting more specific studies, to determine the users' preference of typefaces and legibility levels, in the context of the visual/tactile sign proposed for the system.

Consideration of Jumbo Braille

It was suggested by one participant that Jumbo Braille could be used instead of regular Braille, to help people who are not as experienced with this tactile communication system. More studies would be necessary to determine if Jumbo Braille is more effective than regular Braille, and to establish how would the change of size affect the layout of the visual/tactile sign.

Test the system under winter conditions

It was observed during the benchmarking process, conducted during winter, that seasonal conditions affected the outdoor navigation process. The snow accumulated at the edges of the pathway provided a clear reference for students who used a cane as a mobility aid, and created visual contrast against the cleared pathway, which was darker. Due to limitations of this study, it was not possible to test the prototype during winter as well. Further research would be necessary to determine the effect of the snow on the features of the orientation system, such as the tactile paving surfaces and the visual/tactile sign attached to the informational landmark. Two main questions need to be answered:

1. How would the tactile paving surfaces be affected by the snow?

2. Would the snow and extreme cold affect the tactile legibility of the visual/tactile sign?

Test the system with sighted users

In order to comply with the principles of inclusive design, the proposed orientation system should be tested with sighted participants. Further studies would determine if the system is perceptible, legible and useful for people with 20/20 vision.

Quantitative measurement for the proposed orientation system

One of the limitations of the studies conducted for this Master's thesis project was the small sample of participants. The quantitative and qualitative data collected during the prototype testing phase, suggested that the proposed orientation system would be a positive aid for blind/partially sighted students at the University of Alberta. However, testing the prototype with a larger sample would be necessary, in order to provide a quantitative measurement to be analyzed using statistical techniques.

Delineation of additional routes at the University of Alberta

The results of this study showed the performance of the orientation system on the SUB to CAB route specifically. Further research is necessary to establish all the routes that represent complex areas for navigation at the University of Alberta, for students who are blind/partially sighted, in order to establish the proper application of the system in different settings.

Implementation of similar systems in different locations

It is hypothesized here that similar orientation systems could be implemented in locations other than the University of Alberta. Some features of the proposed system, such as the poles for the four-way intersections, could be applied in similar scenarios. Other features require specific data in order to be of use. Researchers interested in the creation of accessible orientation systems for particular settings, will need to conduct further studies in order to establish major landmarks at the specific location, to reveal environmental clues used by blind/partially sighted users for navigation and orientation, and to identify complex areas of navigation. This information would be particularly valuable for the proper application of tactile paving surfaces, and the design of meaningful informational landmarks. A user-centered and inclusive methodology would be required.

9. CONCLUSION

The outdoor wayfinding system currently used at the University of Alberta is not accessible for users who have low vision, because it relies exclusively on visual means of communication. University students who are blind/partially sighted, stated that they often encounter various difficulties when navigating on-campus. It was hypothesized that an accessible orientation system could help people with low vision to orient themselves better, resulting in a better navigation experience; it could also help improve blind/partially sighted students' traveling time, by making it possible for them to walk more direct routes; and it also may increase the level of confidence of pedestrians with low vision, which is important for independent mobility.

The objective of this Master's thesis project was to develop a proposal for an outdoor orientation system for the University of Alberta, accessible for students who are blind/partially sighted. The use of a user-centered and inclusive design process, as well as the contributions of orientation and mobility experts, was essential for the creation of this accessible orientation system. The early participation of the users helped to address their specific needs for orientation and navigation on-campus. The design investigation conducted included a series of interviews with blind/partially sighted students, and a benchmarking task performed in a specific route on campus. The findings helped to outline the difficulties students frequently encounter while navigating at the University of Alberta, and also helped to determine which features needed to be included in the orientation system, in order to make it accessible for them. The orientation system included:

1. A *guidance texture*, to guide students through open areas
   and paths that are curved.

2. A *four-way intersection texture*, to indicate two paths are intersecting,
   pointing out the possibility of either turning or walking straight.

3. Poles placed at turning points, or *four-way intersection poles*,
   as a second resource to indicate turning points.

4. An *informational landmark,* to present visual/tactile information regarding the location of University major landmarks and their spatial layout.

5 An *information texture*, to indicate the presence of an informational landmark.

A prototype for the proposed orientation system was developed, and tested with four blind/partially sighted students. Participants were asked to walk the same route as was used in the benchmarking task, where the orientation system was installed. The results of the testing procedure showed that some features of the system would require further refinements in order to enhance their accessibility. Specifically, the red used for the tactile paving surfaces, and the usefulness of the four-way intersection poles, were questioned by some participants. This suggested that more studies would be required to improve contrast between the tactile paving surface and the pathway, and find a way to enhance the usefulness of the poles.

In general terms, it could be concluded that the proposed orientation system was accessible for participants who were blind/partially sighted, because it fulfilled the requirements of being conspicuous, legible, and useful for them. According to participants, the general information provided by the orientation system facilitated the navigation process for them. Specifically, they agreed that the guidance texture and the informational landmark were the most useful features of the system. The analysis of the testing results also showed that participants used the proposed orientation system to follow the route from SUB to CAB.

This thesis project should be considered a first approach to an accessible orientation system, and further research in several areas would be necessary for its future implementation. For example, one of the objectives set for the design of this orientation system was to comply with an inclusive design approach by being functional for all U of A students, regardless their level of vision; however, time limitations of this Master's thesis research did not allow the testing of the orientation system with sighted people. This and other opportunities for further investigation, such as testing the performance of the system during winter, or the possibility of implementing

the system in different settings other than the U of A, were outlined and discussed as implications for further research.

Working on a project that was centered on the needs of the users, and that included the audience through the design process, was a rewarding experience. The resulting accessibility of the proposed orientation system could be attributed to the inclusive design process that was followed, and the collaborative effort where designer, users and experts shared their knowledge. The benefits of involving the users, from the conception of the project to the testing of the final product, became obvious in the final results of this Master's thesis.

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ETHICS APPLICATION

UNIVERSITY OF ALBERTA
FACULTY OF ARTS, SCIENCE & LAW RESEARCH ETHICS BOARD

APPLICATION TO CONDUCT RESEARCH
INVOLVING HUMAN PARTICIPANTS

Principal Investigator(s):   **Name(s):** Ximena Rosselló

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Project Title: Orientation system accessible for blind and partially sighted students

Funding Source(s): N/A

Summary of Project / Research Design. Please attach a more detailed proposal
(i.e., 1-2 pages), including a description of the population from which research participants
will be drawn (e.g., university students, nursing home residents) and a discussion of how
research participants will be solicited. Also attach copies of research instruments (e.g.,
questionnaires, interview guides).

Index

SUMMARY OF PROJECT

The University of Alberta main campus covers about 50 city blocks with more than 90 buildings (1). Due to the large number of buildings and open areas, and considering that the signage system relies exclusively on visual perception, on-campus mobility is difficult for partially sighted and blind students. The lack of directional cues and points of reference accessible for partially sighted and blind people may result in disorientation, loss of track and possibly, accidents.

By following a user-centered design process, the main objective of this thesis project is to create an outdoor orientation system to improve on-campus mobility for the blind and partially sighted. Unlike the campus signage used at present, a wayfinding system based on more than visual perception could make the information accessible to all students. In addition, by increasing conspicuousness of pathways it might be possible to increase on-campus safety for people with visual impairments. An accessible system would also help to improve partially sighted and blind students' time management and efficiency related to travel time (see appendix A, letter of support).

The purpose of this study is to set parameters for improvement based on campus situation at present, as well to answer questions about the design and development of an accessible orientation system. The findings of this study will determine:

a) A benchmark regarding the accessibility/safety level of the University's wayfinding system for partially sighted and blind students.

b) Which features should be included in this system.

c) How these features should be designed, produced, and applied to the system in order to make it fully accessible for partially sighted and blind students.

d) Determine the level accessibility and effectiveness of the proposed system.

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(1) http://www.uofaweb.ualberta.ca/facts/nav01.cfm?nav01=1613

Research Design

This study will be conducted in three phases.

Phase I–Interviews

21 legally blind or partially sighted students will be asked to participate, individually. The interview sessions will help to find specific needs of blind and partially sighted students regarding on-campus mobility and wayfinding at the University of Alberta, and also will determine which features should be included in the physical devices comprising the system (i.e. maps, signage, textured pathways). Data will be collected by recording audio.

Content experts will be interviewed to collect information about the special considerations that should be taken into account to create an accessible wayfinding system for partially sighted and blind students.

Phase II–Benchmarking

The benchmarking procedure will help to determine how efficient the actual wayfinding system at the University of Alberta is for students who are partially sighted or legally blind. The findings of this phase will also help to estimate how much, in terms of time management and safety issues, blind and partially sighted students are affected by a wayfinding system that is not accessible to them.

21 legally blind or partially sighted students will be asked to participate individually. Students will be asked to perform a simple task: to walk an outdoor route that is familiar to them (i.e. from Central Administration Building to Students' Union Building). The researcher and a research assistant will observe the student interaction with the environment. Data will be collected by recording video and audio, for later analysis.

Phase III–prototype testing

The findings from Phase I and II (see above) will determine the possible design solutions of the system, and more than one option might be included at this stage. Phase III involves testing the possible design solutions with legally blind or partially sighted students, to find out which ones convey the goals of being perceptible, accessible and legible for them. Testing the possible solutions for the orientation system will also help to determine if its future application on campus could improve students' efficiency and safety when walking.

For the prototype testing, participant students involved in phase II will be asked to walk the same route of the benchmarking task, where the orientation system will be applied to test the effectiveness of the design of the system. The researcher and a research assistant will observe the interaction between the student and the system prototype. Data will be collected by recording video and audio for later analysis.

After the testing, the participants will be asked to take part of an interview to collect their opinion about the prototypes tested.

ASSESSMENT OF RISK TO HUMAN PARTICIPANTS

Phase I–Interviews

There are no known risks for human participants involved in this study.

The interviews involve questions about the students' on-campus mobility experience, including modes of transportation used to get to the University. Specific questions regarding possible elements to be included on the system will also be asked, in order to incorporate the students' mobility knowledge in to the design process (See Appendix E).

Interviews with content experts are intended to reveal information regarding special considerations that should be taken into account to create an accessible wayfinding system for partially sighted and blind students. The questions asked during these sessions will address the expert's specific area of expertise, which may include: mobility training, orientation aids for the partially sighted and the blind, special education and cognitive psychology.

Phase II–Benchmarking

There are minimal risks for human participants involved in this study.

To ensure participants' safety, an expert from Specialized Support and Disabilities Services (SSDS) at the University of Alberta will approve the task assigned to students for the benchmarking study. Students will be asked to walk an outdoor campus route that is familiar to them. The risk to students participating in this study is no greater than might be expected within a regular walk in order to attend classes. The observation will be focused on the accessibility of the environment and not on the students' ability to walk on campus.

Phase III–Prototype Testing

There are minimal risks for human participants involved in this study.

To ensure participants' safety, an expert from Specialized Support and Disabilities Services (SSDS) at the University of Alberta will approve the task assigned to students for the prototype testing. Students will be asked to walk the same route from the benchmarking task, where the orientation system will be applied to test the effectiveness of the design of the system. The risk to students participating in this study is no greater than might be expected within a regular walk in order to attend classes.

Interviews coming after the testing session are intended to reveal information about the functionality and accessibility of the system. The specific questions to be asked cannot be formulated in advance, since they will depend on the previous studies' findings. Nevertheless, they will address the effectiveness of the system and not the students' ability to walk on campus

DESCRIPTION OF PROCEDURES UNDERTAKEN TO REDUCE RISK TO HUMAN PARTICIPANTS

Recruitment

For each phase of this study, an invitation to participate—written and signed by the researcher—will be sent by e-mail to blind and partially sighted students by a representative of the Specialized Support and Disability Services with whom they are already acquainted (see Appendices B.1, B.2 and B.3). The invitation will outline the project and the objectives of the corresponding phase of the study (interview, benchmarking or prototype testing). The participant's role will be described, specifying the approximate time of commitment. Because their involvement is critical for the success of the thesis project, students will be encouraged to participate.

Content experts will be contacted by e-mail and/or phone. An invitation outlining the study objectives will be sent when pertinent (see Appendix B.4).

Location

For the interviews involved in phases I and III, students and researcher will meet at the SSDS main office. Interviews will be held in a close by and accessible location, such as Career and Placements Services or Student Union's offices. The route selected for phases II and III will be familiar to the students.

Information Letter/Consent Forms

For all phases related with this study, an information letter containing a content form will be read to participants at the beginning of the study. Separate letters will be prepared for each phase. Students and content experts will be asked to sign different forms as well.

Students

The information letter will be read to participant students before completing the corresponding task (see Appendices C.1, C.2 and C.3). Here they will be informed that the interviews, benchmarking and prototype testing studies are voluntary, and that the participants are free to leave these sessions at any moment without penalty or need for an explanation. In addition, the information letter will explain the objectives of the correspondent phase of the study. The participant's role will also be described, specifying the approximate time of commitment, the risks involved in the task and confidentiality measures undertaken to protect participants' identity.

The information letter will include a consent form. It will be explained that by signing this form, students might be quoted in the final report and/or public exhibition, but no names or faces will relate to their words to protect their identity. Students will have the opportunity to decline being quoted by signing a form (see Appendices D.1, D.2 and D.3)

Content experts

At the beginning of each interview, content experts will be asked to sign a consent form (see appendix C.4). It will be explained that if permission is given, they may be cited on the final report and/or public exhibition, using their names in association with the quotation.

Data Collection and Privacy/Confidentiality Forms

The researcher will ensure the confidentiality of the students participating in all phases of this study. Data from interviews—related to phases I and III—and the benchmarking study will be collected by audio. Students might be quoted on the final report and/or public exhibition, but no names or faces will relate to their words to protect their identity. If permission is given, interviewed content experts may be cited on the final report and/or public exhibition, using their names in association with the quotation.

Video will be recorded during the benchmarking study and the prototype testing—phases II and III—for later analysis. Videos will not be presented

in public. Still images extracted from the videos may be used for the final report and/or the public exhibition that are mandatory for the Master of Design Thesis, but no faces will be shown and no names will be associated with the images. Students participating might be quoted on the final report and/or public exhibition, but no names or faces will relate to their words to protect their identity. Students will have the opportunity to decline being quoted by signing a form (see Appendices D.1, D.2 and D.3)

Research assistants present at phases II and III will be asked to sign a confidentiality agreement (see Appendix F). Research assistants involved in technical tasks (i.e. making transcriptions, extracting videos from camera, proof-reading the thesis document) will be requested to sign the confidentiality form as well.

Storage and Disposal of Testing Materials
All data collected, testing materials and documentation will be kept in the possession of the researcher in a locked filing cabinet for a period of five years and will be destroyed at the end of that period.

I have read the **UNIVERSITY OF ALBERTA STANDARDS FOR THE PROTECTION OF HUMAN RESEARCH PARTICIPANTS [GFC Policy Manual, Section 66]** and agree to abide by these standards in conducting my research.

_____ Signature of Principal Investigator(s)

_____ Date

(If Student)

_____ Signature of Faculty Supervisor/sponsor

_____ Date

Submit completed form and attached documents to:

**Dr. Lynn Penrod, Chair
Arts, Science, Law Research Ethics Board
Dept of Modern Languages and Cultural Studies
200 Arts Building**
mailto:lpenrod@ualberta.ca
Phone: 492-1199   October, 2004

INTERVIEW MATERIALS

Students

- Invitation letter
- Information letter/consent form
- Decline form
- Interview

Content experts

- Invitation letter
- Information letter/consent form

Dear student,

I'm a graduate student at the Master of Visual Communication Design program, at the University of Alberta. The objective of my thesis project is to create an orientation system to improve on-campus mobility for students who are blind/partially sighted. My research will be conducted in three phases: Individual interviews; an evaluation of the efficiency of the actual wayfinding system; and testing a prototype of the accessible orientation system. My intention is to work in collaboration with those of you who would benefit from this system following a collaborative/user-centered design process, thus your participation is very valuable.

If you are interested in collaborating with this project, I would like to have the opportunity to interview you individually, asking some questions regarding your own on-campus experience. This interview will take about an hour. I will make an audio recording of the interview and—with your consent—quote your words in my thesis report and exhibition; however, your identity will not be revealed.

If you decide to participate, or should you have any questions, please contact me at the following phone number or e-mail address:

990 1225
rossello@ualberta.ca

Thank you for your time,

Ximena Rosselló
Graduate Student

NAME OF STUDY
Orientation system accessible for blind and partially sighted students

NAME OF RESEARCHER
Ximena Rosselló

STUDY INFORMATION
You have been invited to participate in a research project for a Master of Design thesis.
The objective of this thesis project is to gain knowledge of how Visual Communication Design
can help to improve the University of Alberta's outdoor wayfinding system, in order to make it
accessible for students who are blind/partially sighted.

This study begins with an individual interview that will take approximately one hour. This interview
will help to find specific needs you might have regarding mobility and wayfinding at the University
of Alberta, and also will help to determine what features should be included to make the orientation
system accessible.

The interview will be recorded for later analysis. Your words may be quoted in the thesis report
and exhibition, but your name will not be revealed. You can decline to be quoted by signing a form.
The development of this study will follow the *University of Alberta Standards for the Protection
of Human Research Participants*.

Please note that there are no right or wrong answers for the questions involved in this interview.
Your participation is voluntary and you are free to withdraw at any time without penalty or the
need for an explanation.

Thank you very much for your time. For more information, you may contact faculty supervisor
Prof. Susan Colberg, Coordinator Visual Communication Design, Department of Art and Design,
at (780) 492-7859.

I understand:

· The procedures and purpose of this study and have been given the opportunity
  to ask questions.

· That my name will not be used in any written or visual presentation in connection
  with this project.

· That I may withdraw at anytime during the interview session,
  without explanation or penalty.

· All the information presented in this letter, and that by signing I agree to participate
  in the interview session for the research project conducted by Ximena Rosselló,
  Graduate Student at the Visual Communication Design Master program, University
  of Alberta, Department of Art and Design.

Participant's Name   Participant's Signature

Investigator's Name   Investigator's Signature

Date

Name of Study
Orientation system accessible for blind and partially sighted students

Name of Researcher
Ximena Rosselló

By signing this letter, I agree to participate in the interview session, but decline to be quoted in the thesis report and exhibition for the research project conducted by Ximena Rosselló, Graduate Student at the Visual Communication Design Master program, University of Alberta, Department of Art and Design.

Participant's Name   Participant's Signature

Investigator's Name   Investigator's Signature

Date

Thank you for participating on this interview. Remember that there are no right or wrong answers for the questions I am going to ask you.

1. How are you able to use your vision to get around campus?

2. How long have you been a student at the University of Alberta?

3. Do you live in on-campus residence?

4. Do you take public transportation to get to the University? What kind? (Bus/LRT)

5. When you walk to classes, what are your starting points on the routes you often take? (i.e.: LRT station, Bus station next to Education library, the residence building where you live, etc.)

6. In what area of the University do you take most of your classes?

7. When walking on the U of A campus, what are the routes you walk most often? (i.e. from SUB to FAB, etc.).

8. Which routes are more difficult to follow? (i.e.: going from x to y). Why?

9. Please describe a route named in the previous question as you remember it.

10. How long does it take to walk that route? (Approximated time)

11. Which routes are easier to walk? Why?

12. Are there any paths or routes that you think are particularly unsafe to walk? Why?

13. Have you ever walked the route from SUB to CAB? And from SUB to the stairs south of CAB?

14. What do you do when you need to navigate or walk through the University of Alberta campus? Please try to remember all the steps and aids involved.

15. When you walk a route, what kind of environmental cues do you use as a guide?

16. At present, do you think there is a need for an orientation system, accessible for University of Alberta students who are partially sighted or blind? Why?

17. If any, what U of A major landmarks (buildings, sculptures, etc.) are predominant and/or easy to identify for you when walking on-campus?

18. What make those landmarks a good reference point to orientate on-campus?

19. Have you ever used a tactile map? If you have, please answer the next question:

20. Do you find tactile maps easy or hard to use? Why?   E   H

21. There is a possibility that the orientation system would require more than one feature to be effective. Please tell me if you think any of these informational resources would be useful or not:

    a.   Fixed landmarks, placed in strategic points along the routes/pathways   Y   N
    b.   Tactile maps of the U of A   Y   N
    c.   Textured pathways, outdoors   Y   N
    d.   Colored pathways, outdoors   Y   N
    e.   Other (please explain)

22. Would this information be helpful at all if available on fixed landmarks?

    a.   A number assigned to the landmark (i.e. Landmark N° 1)   Y   N
    b.   Saturated color for the landmark   Y   N
    c.   Location of the landmark printed in Braille (i.e. "HUB Mall")   Y   N
    d.   Location of the landmark printed in clear print or large print   Y   N
        please specify:

    e.   Location of the landmark available in audio   Y   N
    f.   Cardinal points represented in tactile symbols (North, South, West, East)   Y   N
    g.   Verbal directions for next landmarks, printed in Braille   Y   N
    h.   Verbal directions for next landmarks, printed in clear print or large print   Y   N
        please specify:

    i.   A tactile map of the near surroundings   Y   N
    j.   A tactile map, showing the predominant U of A reference points   Y   N
    k.   Other, please explain:

23.   Any further comments?

Dear _____,

I'm a graduate student at the Master of Visual Communication Design program, at the University of Alberta. The objective of my thesis project is to create an orientation system to improve on-campus mobility for blind and partially sighted students, which would be applied at the University of Alberta.

In order to develop an accessible system that achieves the principles of inclusive design, my intention is to work using an interdisciplinary approach, following a user–centered design process. I would like to have the opportunity to interview you about your expertise. This interview will take about an hour. I may make an audio recording of the interview and—with your consent—your words might be quoted in my thesis report and exhibition.

If you have any questions, please contact me at the following phone and e-mail address:

990 1225
rossello@ualberta.ca

Thank you for your time,

Ximena Rosselló
Graduate Student

Name of Study
Orientation system accessible for blind and partially sighted students

Name of Researcher
Ximena Rosselló

Study Information
Thank you very much for your time. You have been invited to participate in a research project for a Master of Design thesis. The objective of this thesis project is to gain knowledge of how Visual Communication Design can help to improve the University of Alberta outdoor wayfinding system, in order to make it accessible for partially sighted and blind students.

In order to develop an accessible system that achieves the principles of inclusive design, my intention is to work using an interdisciplinary approach, following a user–centered design process. This study consists in an individual interview that will take approximately one hour. This interview will help to determine special considerations that should be taken into account to create an accessible wayfinding system for partially sighted and blind students, based on your expertise.

The interview will be recorded for later analysis. With your consent, your words may be quoted in the thesis report and exhibition. The development of this study will follow the *University of Alberta Standards for the Protection of Human Research Participants*.

There are no known risks involved in participation in this study. If you require more information, you may contact faculty supervisor Prof. Susan Colberg, Coordinator Visual Communication Design, Department of Art and Design, at (780) 492-7859.

Do you understand:

The procedures and purpose of this study and have been given the opportunity to ask questions.

That your words may be quoted in the thesis report and public exhibition

That your name may be used in association with your words

The risk and benefits involved in this study

That your participation is voluntary

All the information presented in this letter, and that by signing you agree to participate in the interview session for the research project conducted by Ximena Rosselló, Graduate Student at the Visual Communication Design Master program, University of Alberta, Department of Art and Design.

Do you permit:

| The researcher to use your words and your name in the thesis report and exhibition?

Participant's Name   Participant's Signature

Investigator's Name   Investigator's Signature

Date

BENCHMARKING MATERIALS

- Invitation letter
- Information letter/consent form
- Decline form
- Confidentiality form
  for research assistants
- Route description

Dear student,

As you may know already, I'm a graduate student at the Master of Visual Communication Design program, at the University of Alberta. The objective of my thesis project is to create an orientation system to improve on-campus mobility for students who are blind/partially sighted. My intention is to work in collaboration with those of you who would benefit from this system following a collaborative/user–centered design process, thus your participation is very important.

I would like to invite you to participate in the second phase of this project: a benchmarking process that will help to determine how efficient the actual wayfinding system at the University of Alberta is for you. The findings of this study will also help to estimate how much, in terms of time management and safety issues, blind and partially sighted students are affected by a wayfinding system that is not accessible for them.

The benchmarking task will consist in walking a specific route: from the East entrance of the Student's Union Building (SUB) to the West entrance of Central Administration Building (CAB). This task might take up to half an hour. Your feedback in this process is critical for the success of the project, therefore I will ask you to talk and record your experience while you are walking. With your consent, I may quote your words in my thesis report and exhibition; however, your identity will not be revealed. Also with your permission, I will take a video for later analysis. Videos will not be presented in public.

Your contribution and collaboration is important and will be very much appreciated. If the route selected for the benchmarking process is not familiar for you, please let me know; we can arrange to have a guide to walk with you. If you decide to participate and would like to schedule an appointment, or should you have any questions or concerns, please contact me by February 17th at the following phone or e-mail address:

990 1225
rossello@ualberta.ca

Thank you for your time,

Ximena Rosselló
Graduate Student

Name of Study
Orientation system accessible for blind and partially sighted students

Name of Researcher
Ximena Rosselló

Study Information
You have been invited to participate in a research project for a Master of Design thesis. The objective of this thesis project is to gain knowledge of how Visual Communication Design can help to improve the University of Alberta outdoor wayfinding system, in order to make it accessible for students who are blind/partially sighted.

This study consists in a benchmarking process that will help to determine how efficient the actual wayfinding system at the University of Alberta is for you. The findings of this study will also help to estimate how much, in terms of time management and safety issues, blind and partially sighted students are affected by a wayfinding system that is not accessible.

The benchmarking task will consist in walking from the East entrance of the Student's Union Building (SUB) to the West entrance of Central Administration Building (CAB). You might take as much time as you need to finish this task. Once finishing the walk—and only if you feel comfortable and agree to do so—I will also ask you to walk back from CAB to SUB.

Your feedback in this process is critical for the success of the project; that is why I will ask you to talk and record your experience while you are walking. With your consent, your words might be quoted in my thesis' report and exhibition, but your identity will not be revealed. You can decline to be quoted by signing a form.

A research assistant will take a video for later analysis. Please note that the researcher and the assistant's observation will be focused on the accessibility of the environment and not on your ability to walk on-campus. The assistant has signed a confidentiality agreement, and the video will not be presented in public. The researcher and research assistant involved in this project will follow the *University of Alberta Standards for the Protection of Human Research Participants.*

There are minimal risks associated with the physical task required for this study, nevertheless there are no greater than might be expected within a regular walk in order to attend classes. Please remember that your participation is voluntary and you are free to withdraw at any time without penalty or the need for an explanation.

Thank you very much for your time. For more information, you may contact faculty supervisor Prof. Susan Colberg, Coordinator Visual Communication Design, Department of Art and Design, at (780) 492-7859.

I understand:

· The procedures and purpose of this study and have been given the opportunity to ask questions.

· That my name will not be used in any written or visual presentation in connection to this project.

· That there are minimal risks associated with the physical task required for this study.

· That my participation in this study is voluntary, and that I may withdraw at anytime during the benchmarking session, without explanation or penalty

· All the information presented in this letter, and that by signing I agree to participate in the benchmarking study for the research project conducted by Ximena Rosselló, Graduate Student at the Visual Communication Design Master program, University of Alberta, Department of Art and Design.

Participant's Name   Participant's Signature

Investigator's Name   Investigator's Signature

Date

Name of Study
Orientation system accessible for blind and partially sighted students

Name of Researcher
Ximena Rosselló

By signing this letter, I agree to participate in the benchmarking study, but decline to be quoted in the thesis report and exhibition for the research project conducted by Ximena Rosselló, Graduate Student at the Visual Communication Design Master program, University of Alberta, Department of Art and Design.

Participant's Name   Participant's Signature

Investigator's Name   Investigator's Signature

Date

NAME OF STUDY
Orientation system accessible for blind and partially sighted students

NAME OF RESEARCHER
Ximena Rosselló

I, _____ , research assistant for the thesis project mentioned above, agree to:

1. Keep all the information regarding this thesis project confidential, by not discussing or sharing it with anyone other than the researcher.

2. Keep all the information regarding this thesis project secure while in my possession.

3. Return all research information shared with me to the researcher, once completing my task.

4. Erase or destroy all research information regarding this thesis project, in any form or format that is not returnable to the researcher (e.g., information stored on computer hard drive) once completing my task.

Researcher   Researcher   Date
(print name)   (signature)

Research Assistant   Research Assistant   Date
(print name)   (signature)

From East entrance of Student's Union Building (SUB) to West entrance
of Central Administration Building (CAB)

Starting at SUB's east entrance, you will step out of the building facing east. Walk straight in
that direction until you reach the T intersection. Turn left, you will be facing north. Walk in that
direction. You will notice an intersection with a path directed northeast. Don't take that path, just
keep walking straight. You will reach a four-way intersection. Keep walking in the same direction
(North) until you reach a second four-way intersection. Your will notice a light post at your right
hand side. Turn right, you will be facing east. Walk east following the pathway. At the end of the
path, you will reach an open area; keep walking straight until you reach a bike rack. Turn left, walk a
couple of steps and then turn right. The CAB doors will be in front of you.

From Central Administration Building (CAB) West entrance towards East entrance of
Student's Union Building (SUB)

Starting at CAB's West entrance, you will step out of the building facing west. You need to keep
that direction. You can use the wall located on the left hand to keep your line of direction; you can
also use the garbage located at the end of the wall to square up facing west. Walk straight until you
reach an open area that splits in 6 different pathways. Keep walking in the same direction (west)
about 20 steps until you reach the pathway that leads west. Follow that pathway until you reach a
four-way intersection. You might identify this intersection because there are large trees on both sides
of the path just before reaching it, although they are a bit far away to be cane detectable. At that
intersection, turn left. You will be facing south. Walk south following the pathway. You will detect a
phone booth and a trashcan at your right hand side, which means that you reach a second four-way
intersection. Keep walking in the same direction (South). Eventually, you will detect a low wall
that can be use for trailing, although right now is covered with snow. You will also detect a metallic
recycling bin—painted in dark green—, a trashcan and a brick column at the right hand side of the
path. This mean you have reached the Alumni walk, which you need to cross. Keep walking South.
You will find an opening for a path directed west. Don't use that opening. You will also find a path
directed southwest, don't take it, just keep walking south. As you get closer to SUB, you will hear
the doors by your right side. Keep walking until you reach a concrete column. Turn right when
you find the column. You will be facing West, and the SUB doors will be in front of you.

PROTOTYPE TESTING MATERIALS

- Invitation letter
- Information letter/consent form
- Decline form
- Confidentiality form
  for research assistants
- Route description
- Questionnaire

Dear student,

As you know already, I'm a graduate student at the Master of Visual Communication Design program, at the University of Alberta. The objective of my thesis project is to create an orientation system to improve on-campus mobility for blind and partially sighted students. My intention is to work in collaboration with those of you who would benefit from this system following a collaborative/user—centered design process, thus your participation is very valuable.

I would like to invite you to participate in a prototype testing study that will help to determine the efficiency of the design of the accessible orientation system I am working on. By participating, you will help to reveal if the design solutions convey the goals of being perceptible, easy to use and legible. The findings of this study will also help to determine if the future application of this system could improve your time management and safety.

The prototype testing will consist of walking from the East entrance of the Student's Union Building (SUB) to the West entrance of Central Administration Building (CAB), path where the orientation system will be applied. Your feedback during this process is critical for the success of the project; that is why I will ask you to talk and record your experience while you are walking. This task might take up to half an hour. After the testing, I will need to ask you some questions regarding the orientation system. I'll send a questionnaire by e-mail by the end of the testing day, which you can answer at home and send back to me. It would take about half an hour to respond the questionnaire. With your consent, your words might be quoted in my thesis report and exhibition; however, your identity will not be revealed. Also with your permission, I will take a video of the testing process for later analysis. Videos will not be presented in public.

Your contribution and collaboration is important and would be very much appreciated. If you decide to participate, or should you have any questions, please contact me at the following phone number or e-mail address:

990 1225
rossello@ualberta.ca

Thank you for your time,

Ximena Rosselló

Name of Study
Orientation system accessible for blind and partially sighted students

Name of Researcher
Ximena Rosselló

Study Information
You have been invited to participate in a research project for a Master of Design thesis. The objective of this thesis project is to gain knowledge of how Visual Communication Design can help to improve the University of Alberta outdoor wayfinding system, in order to make it accessible for students who are blind/partially sighted.

This study consists of a prototype testing that will help to determine the efficiency of a design for an accessible orientation system I am working on. By participating, you will help to reveal which possible design solutions convey the goals of being perceptible, easy to use and legible. The findings of this study will also help to determine if the future application of this system could improve your time management and safety.

Please remember that your participation is voluntary and you are free to withdraw at any time without penalty or the need for an explanation.

The prototype testing may take up to an hour and a half, and consists of two steps:

1. Using the prototype
   You will be asked to walk from the East entrance of the Student's Union Building (SUB) to the West entrance of Central Administration Building (CAB), route where the orientation system has been applied. Your feedback during this process is critical for the success of the project; that is why I will ask you to talk and record your experience while you are walking and interacting with the orientation system. In addition, a research assistant will take a video for later analysis. Please note that the researcher and the assistant's observation will be focused on the effectiveness of the design of the system and not your ability to walk on campus. The assistant has signed a confidentiality agreement, and the video will not be presented in public.

   You might take as much time as you need to finish this task. There are minimal risks associated with the physical task involved in this study, nevertheless there are no greater than might be expected within a regular walk in order to attend classes.

2. Questionnaire
   After the walk, I will ask you some questions regarding the orientation system that has been tested. You can answer the questionnaire at home and send it to me by e-mail.

Your words—both from the testing and the questionnaire—might be quoted in my thesis report and exhibition. However, your identity will not be revealed. You can decline to be quoted by signing a form. The researcher and research assistant involved in this project will follow the *University of Alberta Standards for the Protection of Human Research Participants*.

Thank you very much for your time. For more information, you may contact faculty supervisor Prof. Susan Colberg, Coordinator Visual Communication Design, Department of Art and Design, at (780) 492-7859.

I understand:

·   The procedures and purpose of this study and have been given the
    opportunity to ask questions.

·   That my name will not be used in any written or visual presentation in connection
    to this project.

·   That there are minimal risks associated with the physical task required for this study.

·   That my participation in this study is voluntary, and that I may withdraw
    at anytime during the benchmarking session, without explanation or penalty

·   All the information presented in this letter, and that by signing I agree to participate
    in the prototype testing for the research project conducted by Ximena Rosselló,
    Graduate Student at the Visual Communication Design Master program, University
    of Alberta, Department of Art and Design.

Participant's Name   Participant's Signature

Investigator's Name   Investigator's Signature

Date

Name of Study
Orientation system accessible for blind and partially sighted students

Name of Researcher
Ximena Rosselló

By signing this letter, I agree to participate in the prototype testing, but decline to be quoted in the thesis report and exhibition for the research project conducted by Ximena Rosselló, Graduate Student at the Visual Communication Design Master program, University of Alberta, Department of Art and Design.

Participant's Name   Participant's Signature

Investigator's Name   Investigator's Signature

Date

NAME OF STUDY
Orientation system accessible for blind and partially sighted students

NAME OF RESEARCHER
Ximena Rosselló

I, _____ , research assistant for the thesis project mentioned above, agree to:

1. Keep all the information regarding this thesis project confidential, by not discussing or sharing it with anyone other than the researcher.

2. Keep all the information regarding this thesis project secure while in my possession.

3. Return all research information shared with me to the researcher, once completing my task.

4. Erase or destroy all research information regarding this thesis project, in any form or format that is not returnable to the researcher (e.g., information stored on computer hard drive) once completing my task.

Researcher   Researcher   Date
(print name)   (signature)

Research Assistant   Research Assistant   Date
(print name)   (signature)

From East entrance of Student's Union Building (SUB) to West entrance of Central Administration Building (CAB)

Starting at SUB's east entrance, you will step out of the building facing east. Walk straight in that direction until you reach the T intersection. Turn left, you will be facing north. Walk in that direction. You will cross an open area called the 'Alumni walk', and you might detect several paths going in different directions. Keep walking north. You will detect a guidance texture once exiting the Alumni walk. Please follow this texture: the direction of the raised bars will be parallel to your line of direction; therefore, by following the bars, the texture would guide you to the path going north. Follow that pathway. Before reaching the four-way intersection where you have to turn right, you will feel a texture similar to the one that guided you a while ago. Unlike the guidance texture presented before, the raised bars will be across to your line of direction. The purpose of the across bars is to indicate the possibility of turning. Right after the across bars you will reach a tile with raised bars forming a 90° angle. At this point you will have to turn right (east). You can check if you are at the turning point by detecting a bright red, square-based, plastic pole placed at the corner of the intersection. Walk towards east. At some point along the pathway you will detect a different texture, one that clearly differs from the pathway's paving because it is rough. This texture is indicating the presence of the informational landmark. When you feel this texture turn left (north) and walk until you detect the informational landmark identified as '3.a'. Please take your time to explore the information presented at the landmark. There are two Braille locators at the left edge of the sign that will lead you to the Braille text. Try to use the information presented at the landmark to find your way towards the west entrance of CAB.

Thank you for your time. I have provided important instructions regarding the completion of the questionnaire. Please read them carefully before starting. If you have any questions or concerns, you can contact me at:

9901225
rossello@ualberta.ca

Thank you very much,

Ximena Rossello
Graduate Student

Instructions
This questionnaire has been divided in five sections:
A. System's conspicuousness
B. System's legibility
C. Usefulness of the information
D. Personal feedback.

There are four topics within each section: Guidance texture, Four-way intersection, Informational landmark and General observations. You will find multiple–choice questions with five alternative responses, please mark the one that best reflects your experience using the system (in some cases, a 'not applicable' alternative has been added). In addition, there are open questions that will require you to write a brief explanation instead of marking an alternative.

Section A. System's conspicuousness/detectability
The intention of this section is to find out how conspicuous (detectable?) was the system. Feel free to add your comments anytime.

   Guidance texture:
1) The guidance texture presented at the beginning of the route was:
      a. Very easy to detect
      b. Easy to detect
      c. Not hard nor easy to detect
      d. Hard to detect
      e. Very hard to detect

2) Please explain how did you detect the guidance texture (i.e. using your feet, using your cane, visually, etc.):

3) How would you describe the area covered by the guidance texture?

Four-way intersection:

4) The textured surface at the four-way intersection was:
   a. Very easy to detect
   b. Easy to detect
   c. Not hard nor easy to detect
   d. Hard to detect
   e. Very hard to detect

5) Please explain how did you detect the texture (i.e. using your feet, using your cane, visually, etc.).

6) How would you describe the texture at the four-way intersection?

7) The pole placed on the corner of the intersection was:
   a. Very easy to detect
   b. Easy to detect
   c. Not hard nor easy to detect
   d. Hard to detect
   e. Very hard to detect

8) Please explain how did you detect the pole (i.e. using your sight, using your cane, etc.):

Informational landmark (sign):

9) The 'information texture' (the surface indicating where the sign was placed) was:
   a. Very easy to detect
   b. Easy to detect
   c. Not hard nor easy to detect
   d. Hard to detect
   e. Very hard to detect

10) Please explain how did you detect the texture (i.e. using your feet, using your cane, visually, etc.):

11) The 'informational landmark' (the sign) was:
   a. Very easy to detect
   b. Easy to detect
   c. Not hard nor easy to detect
   d. Hard to detect
   e. Very hard to detect

12) Please explain how did you detect the informational landmark (i.e. using your sight, using your cane, etc.):

General observations:

13) What is your opinion about the conspicuousness of the system?

14) How would you improve the system's conspicuousness?

Section B. System's legibility

The intention of this section is to find out how legible was the system by tactile and/or visual means. Feel free to add your comments.

Guidance texture:

15) The direction of the bars of the guidance texture (placed at the beginning of the route, when exiting the alumni walk) was:
   a. Very easy to distinguish
   b. Easy to distinguish
   c. Not hard nor easy to distinguish
   d. Hard to distinguish
   e. Very hard to distinguish

16) At the beginning of the route, was the direction of the bars parallel or transversal to your line of direction?

17 Please explain how did you detect the direction of the bars (using your feet, using your cane, visually, etc.):

18) Did you feel that the process of following the guidance text was a clear solution for navigating complicated areas, such as the Alumni walk?

Four-way intersection:

19) The direction of bars of the four-way intersection's texture was:
   a. Very easy to distinguish
   b. Easy to distinguish
   c. Not hard nor easy to distinguish
   d. Hard to distinguish
   e. Very hard to distinguish

20) At the four-way intersection, was the direction of the bars parallel or transversal to your line of direction?

21) Please explain how did you detect the direction of the bars (using your feet, using your cane, visually, etc.):

22) In your opinion, was the concept of having a different direction for the raised bars a clear way to indicate turning points?

23) Were the poles a clear way to indicate turning points?

Informational landmark:

24) The 'information texture' (the surface indicating where the sign was placed) was:
   a. Very easy to distinguish from the pathway's texture
   b. Easy to distinguish from the pathway's texture
   c. Not hard nor easy to distinguish from the pathway's texture
   d. Hard to distinguish from the pathway's texture
   e. Very hard to distinguish from the pathway's texture

25) Please explain how did you detect the texture (using your feet, using your cane, visually, etc.):

26) Did the informational texture help you to find the landmark?

27) Please describe the informational landmark (sign) as you remember it.
   Try to be as precise as possible:

28) The printed text on the informational landmark was:
   a. Very easy to read
   b. Easy to read
   c. Not easy nor hard to read
   d. Hard to read
   e. Very hard to read
   f. Not applicable
   Please explain why:

29) The Braille text on the informational landmark was:
   a. Very easy to read
   b. Easy to read
   c. Not easy nor hard to read
   d. Hard to read
   e. Very hard to read
   f. Not applicable
   Please explain why:

30) When using tactile perception, the identification number ('3.a') on the informational landmark was:
   a. Very easy to distinguish by touch
   b. Easy to distinguish by touch
   c. Not easy nor hard to distinguish by touch
   d. Hard to distinguish by touch
   e. Very hard to distinguish by touch
   f. Not applicable
   Please explain why:

31) When using visual perception, the identification number ('3.a') on the informational landmark was:
   a. Very easy to distinguish
   b. Easy to distinguish
   c. Neither easy nor hard to distinguish
   d. Hard to distinguish
   e. Very hard to distinguish
   f. Not applicable
   Please explain why:

32) When using tactile perception, the directional symbol was:
   a. Very easy to understand by touch
   b. Easy to understand by touch
   c. Neither easy nor hard to understand by touch
   d. Hard to understand by touch
   e. Very hard to understand by touch
   f. Not applicable
   Please explain why:

33) When using visual perception, the directional symbol was:
    a. Very easy to understand
    b. Easy to understand
    c. Not easy nor hard to understand
    d. Hard to understand
    e. Very hard to understand
    f. Not applicable
    Please explain why:

General observations:
34) How could the legibility of the system be improved?

Section C. Usefulness of the information

The intention of this section is to find if the system was useful for on campus navigation. I will ask you to remember the experience of walking the same route without the system, in order to compare both situations.

Guidance texture:
35) The guidance texture at the beginning of the route (when exiting the Alumni walk) made the task of finding the way:
    a. Much easier
    b. Easier
    c. Neither easier nor harder
    d. Harder
    e. Much harder
    Please explain why:

Four-way intersection:
36) The texture presented at the four-way intersection made your turning:
    a. Much easier
    b. Easier
    c. Neither easier nor harder
    d. Harder
    e. Much harder
    Please explain why:

37) In comparison with the walk for the benchmarking process, the pole at the corner of the intersection made the task of finding the turning point:
a. Much easier
b. Easier
c. Neither easier nor harder
d. Harder
e. Much harder
Please explain why:

Informational landmark:
38) The information presented on the informational landmark made the navigation on that specific area (Quad):
a. Much easier
b. Easier
c. Neither easier nor harder
d. Harder
e. Much harder
Please explain why:

39) Did the tactile symbol with directions help you to picture where were you standing in relation with the U of A campus?

40) Of the information presented on the informational landmark, what things did you find the most valuable for on campus orientation? Why?

General observations:
41) In general, the information provided by the system the navigation:
a. Much easier
b. Easier
c. Neither easier nor harder
d. Harder
e. Much harder
Please explain why:

42) How would you improve the orientation system to make it more useful?

43) Do you think that by implementing this system at the U of A, the process of navigating on campus could be improved for you? How?

44) Do you think that the system could help to make you feel safer or more confident when traveling on your own? Please explain:

45) If the system were applied on that route for real, would you walk that path by yourself? Why?

Section D. Personal feedback

Is there anything about the system you thinks it is important to point out, but have not been addressed on this questionnaire? Please feel free to add any comments:

RESULTS OF PROTOTYPE TESTING

Guidance texture

Conspicuosness
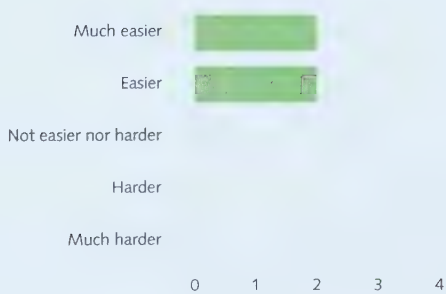Detecting the guidance texture at the beginning of the route was:

Very easy	
Easy	
Not easy nor hard	
Hard	
Very hard	

0 1 2 3 4

Legibility
Following the direction of the guidance texture was:

Very easy	
Easy	
Not easy nor hard	
Hard	
Very hard	

0 1 2 3 4

Usefulness
The guidance texture made the task of finding the pathway:

Much easier	
Easier	
Not easier nor harder	
Harder	
Much harder	

0 1 2 3 4

Usefulness
Guidance texture was a good solution for navigating complex areas:

Yes	
No	

0 1 2 3 4

Positive response

Neutral response
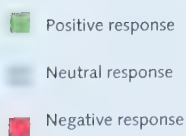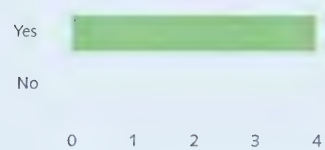
Negative response

Four-way intersection texture
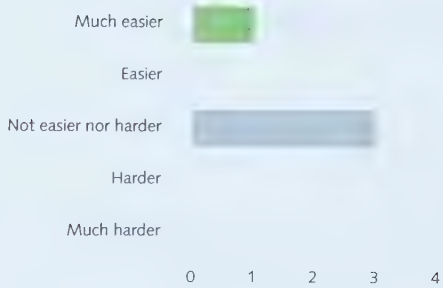
Conspicuousness
Finding the four-way
intersection texture was:

Very easy	
Easy	
Not easy nor hard	
Hard	
Very hard	

0 1 2 3 4

Legibility
Following the four-way
intersection texture was:

Very easy	
Easy	
Not easy nor hard	
Hard	
Very hard	

0 1 2 3 4
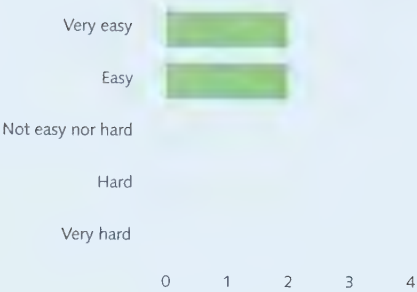
Usefulness
The four-way intersection
texture made the turning:

Much easier	
Easier	
Not easier nor harder	
Harder	
Much harder	

0 1 2 3 4
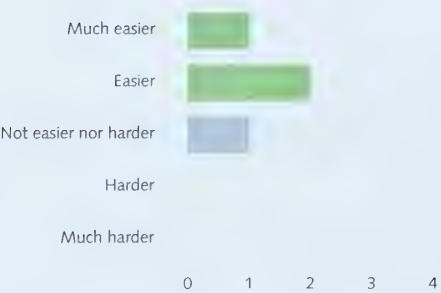
Positive response

Neutral response

Negative response

Four-way intersection poles

Conspicuousness
Finding the pole at the four-way intersection was:

Very easy	
Easy	
Not easy nor hard	
Hard	
Very hard	

0 1 2 3 4
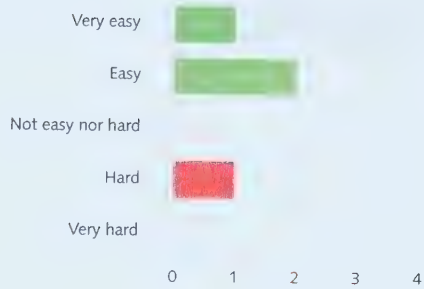
Legibility
Did the pole help to indentify the turning point?

Yes	
No	

0 1 2 3 4
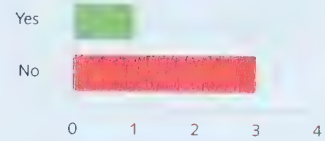
Usefulness
The pole made the task of finding the turning point:

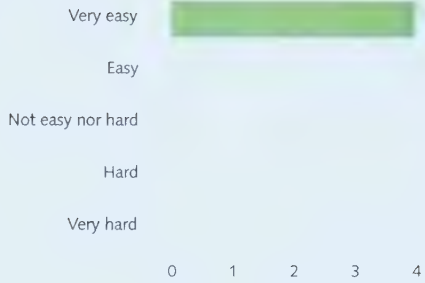|	
Much easier	
Easier	
Not easier nor harder	
Harder	
Much harder	

0 1 2 3 4

- Positive response
- Neutral response
- Negative response

Information texture

Conspicuousness
Finding the information texture was:

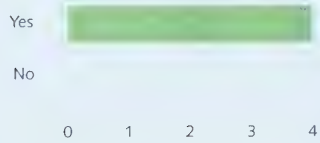|					
Very easy					
Easy					
Not easy nor hard					
Hard					
Very hard					
	0	1	2	3	4

Legibility
Distinguishing the information texture from the paving surface of the pathway was:

Very easy					
Easy					
Not easy nor hard					
Hard					
Very hard					
	0	1	2	3	4
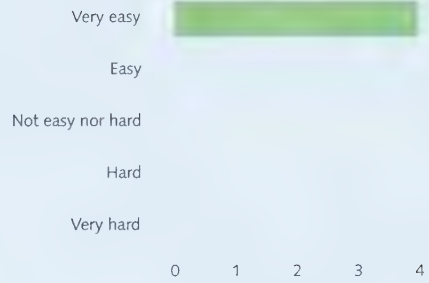
Usefulness
Was the information texture helpful to find the informational landmark:

Yes					
No					
	0	1	2	3	4

Positive response

Neutral response

Negative response

Informational landmark

Conspicuousness
Finding the informational landmark was:
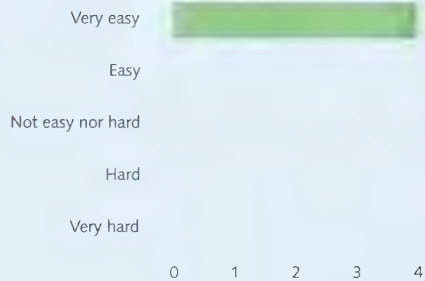
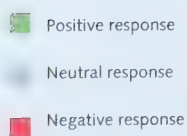|					
Very easy					
Easy					
Not easy nor hard					
Hard					
Very hard					
	0	1	2	3	4

Legibility
Distinguishing identification number '3.a' by tactile means was:

Very easy					
Easy					
Not easy nor hard					
Hard					
Very hard					
Not applicable					
	0	1	2	3	4

Legibility
Distinguishing identification number '3.a' by visual means was:

Very easy					
Easy					
Not easy nor hard					
Hard					
Very hard					
Not applicable					
	0	1	2	3	4

Positive response

Neutral response

Negative response
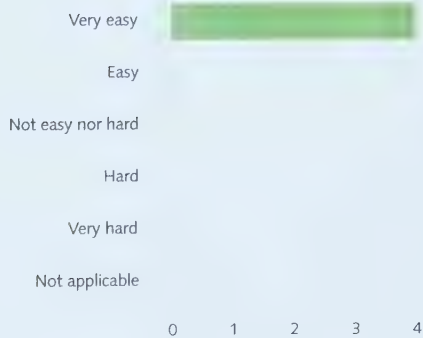
Informational landmark

Legibility
Understanding the compass
by tactile means was:

	0	1	2	3	4
Very easy					
Easy					
Not easy nor hard					
Hard					
Very hard					
Not applicable					
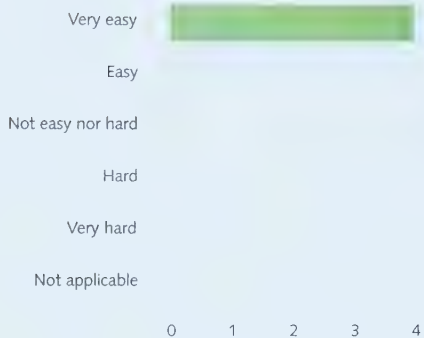
Legibility
Understanding the compass
by visual means was:
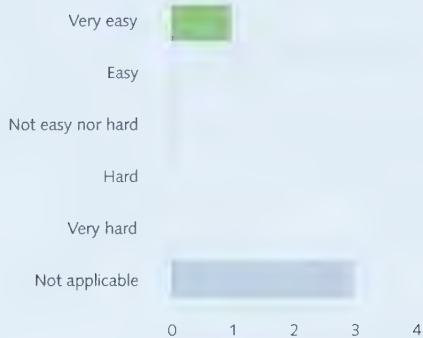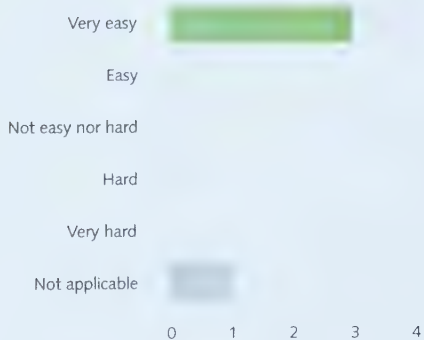
	0	1	2	3	4
Very easy					
Easy					
Not easy nor hard					
Hard					
Very hard					
Not applicable					

Legibility
Reading the Braille
text was:

	0	1	2	3	4
Very easy					
Easy					
Not easy nor hard					
Hard					
Very hard					
Not applicable					

Legibility
Reading the text in large print
format was:

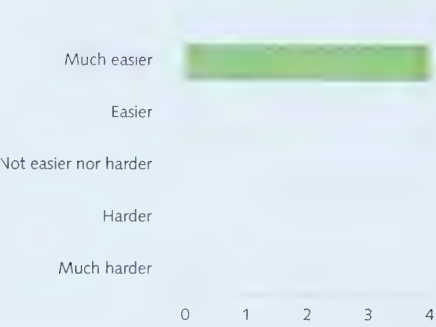|	0	1	2	3	4
Very easy					
Easy					
Not easy nor hard					
Hard					
Very hard					
Not applicable					
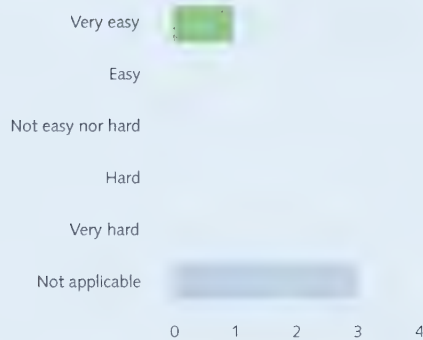
- Positive response
- Neutral response
- Negative response

Informational landmark

Usefulness
Information at the informational landmark made navigation at Quad:

Response	Count
Much easier	(bar to 4)
Easier	
Not easier nor harder	
Harder	
Much harder	

0 1 2 3 4

Usefulness
Information at landmark was helpful to find the way to CAB:

Response	Count
Yes	(bar to 4)
No	

0 1 2 3 4
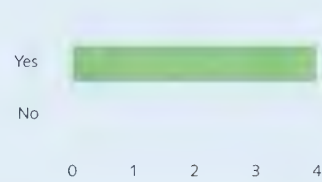
Usefulness
Compass helped to picture user's position in relation to the U of A campus:

Response	Count
Yes	(bar to 4)
No	

0 1 2 3 4

Usefulness
Area identification (Quad) and facing direction (north) were useful:

Response	Count
Yes	(bar to 4)
No	

0 1 2 3 4

- Positive response
- Neutral response
- Negative response
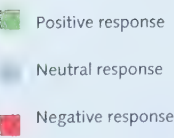
General evaluation

Conspicuousness
The system was
conspicuous enough:
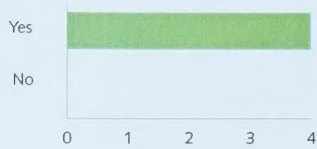
Yes	
No	

(bar chart with x-axis: 0, 1, 2, 3, 4; "Yes" bar reaches 4)

Usefulness
Information provided by the
orientation system made the
navigation:

Much easier	
Easier	
Not easier nor harder	
Harder	
Much harder	

(bar chart with x-axis: 0, 1, 2, 3, 4; "Much easier" bar reaches 3, "Easier" bar reaches 1)
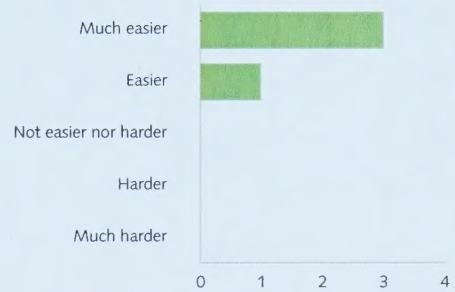
Usefulness
If the system were implemented
on the route, participants would
navigate that path on their own:

Yes	
No	

(bar chart with x-axis: 0, 1, 2, 3, 4; "Yes" bar reaches 4)

- ■ Positive response
- ■ Neutral response
- ■ Negative response